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MONTHLY WEATHER REVIEW

SEPTEMBER 1940

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MONTHLY WEATHER REVIEW

Editor, EDGAR W. WOOLARD

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HIGHEST AND LOWEST SEA-LEVEL PRESSURES OBSERVED IN THE UNITED STATES

By EDWARD H. BOWIE

[Weather Bureau, San Francisco, Calif., June 1940]

A mass of statistics is contained in the Climatological Record kept at all Weather Bureau stations manned by commissioned personnel, in the United States and their territories and insular possessions. These statistics cover monthly and annual averages, and extremes of barometric pressures reduced to, and not reduced to, sea level; averages of temperatures by days, months, and years, and extremes; various values for wind directions and velocities; precipitation data in the form of monthly and annual averages; records of unusual falls of rain in short periods of time and falls of snow (unmelted) and rainfall and snowfall by days; and records of sunshine and nebulosity. Dates of thunderstorms and other unusual phenomena are entered in this log, which now consists of several large books at stations having long records. It would be interesting to speculate on why those interested in writing on the climates of the United States do not more frequently call for the data contained in these record books. Perhaps, sooner or later, these highly valued logs, or copies of them, will be placed in the Hall of Archives in Washington where all students of climate of our country may consult them.

Among the interesting facts contained in these record books are those of the highest and lowest sea-level pressures observed. So far as is known the record of these extreme pressures has never heretofore been brought together for publication, although the station Annual Meteorological Summaries contain them.

On February 3, 1940, letters were addressed to all Weather Bureau stations asking them to extract from the Climatological Record Book the data relating to the highest and lowest sea-level pressures observed at their respective stations since these data were first recorded. The data thus gathered for all regular Weather Bureau stations in the United States having a length of record of more than 10 years will be found in the table that follows. These pressures are all reduced to a common datum, sea level, in accordance with internationally recognized procedure.

An examination of the extremes given in the table discloses the fact that the highest reduced pressure ever observed at a Weather Bureau station in the United States was 31.29 inches at Lander, Wyo., on December 20, 1924; and the lowest, 27.61 inches at Miami, Florida, on September 18, 1926. While the Miami record is that of a tropical cyclone, it is interesting to have here again recorded the extremely low pressure observed at St. Louis, Mo., at the time of the occurrence of a tornado on May 27, 1896. In the article on this tornado by H. C. Frankenfield, MONTHLY WEATHER REVIEW, March 1896, there is added a note to the effect that an aneroid barometer privately owned by Park Commissioner Klemm showed a reading, when reduced to sea-level, of 27.30 inches. The place of observation was near the center of the tornado. It should also be noted that during the hurricane of September 2, 1935, a pressure of 26.35 inches was observed at one of the Florida Keys (MONTHLY WEATHER REVIEW, October 1935, p. 295).

A further examination of the data in this table discloses the fact that the least range in sea-level pressure for any station has been 1.07 inches at San Diego, Calif., in a period of 68 years; and that the maximum range for any station has been 3.02 inches, at Hartford, Conn., in a period of 35 years.

According to months of occurrence, 60 percent of the highest pressures observed occurred in the month of January, less than 20 percent occurred in February and December, respectively, and less than 1 percent occurred in March and likewise in November. At no station was the highest pressure of record observed in any of the months of April to October inclusive.

Unlike the occurrences of the highest pressure, lowest pressures of record were recorded at one or more stations in all months save June and July. The greatest frequency of occurrence of lowest pressures of record attending winter cyclones was in January, more than 30 percent of the recorded lowest pressures occurring in that month. A secondary frequency of occurrence of the lowest pressures of record is in September and this is unquestionably associated with the tropical storms of this time of the year. All record low pressures in September occurred at stations on or near the Gulf of Mexico and the Atlantic Ocean. The lowest pressures of record for the months of August and October likewise occurred at stations on or near the Gulf of Mexico and the Atlantic Ocean and were no doubt associated with tropical cyclones. Stations in other parts of the United States recorded no lowest pressures of record in any month from June to October inclusive. It follows that the maximum number of lowest pressures of record are associated with winter cyclones and a secondary maximum of frequency of occurrence of lowest pressures of record occurs in connection with the tropical cyclones of the late summer and the fall months.

The extreme range of pressure for the United States is 3.68 inches, it being the difference between the maximum of record, 31.29, at Lander, and the lowest of record, 27.61, at Miami.

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TABLE 1.—*Extremes and range of pressure (in inches reduced to sea-level) for the period of record at Weather Bureau stations*

[Records include January 1940]

Station	Length of record	Highest	Date	Lowest	Date	Range
	Years	*Inches*	*M. D. Y.*	*Inches*	*M. D. Y.*	*Inches*
Abilene	54	31.06	2/12/99	29.18	3/20/32	1.88
Albany	66	31.10	1/31/20	28.46	1/3/13	2.64
Alpena	48	31.09	2/9/34	28.66	3/6/29	2.43
Amarillo	48	31.01	12/20/24	29.05	2/12/99	1.96
Apalachicola	18	30.70	1/6/24	29.06	*9/30/29	1.64
Asheville	37	30.90	1/6/24	29.02	*1/19/36	1.88
Atlanta		30.79	1/6/24	29.08	1/11/18	1.71
Atlantic City	66	30.98	1/27/13	28.37	3/6/32	2.61
Augusta	68	30.85	1/2/99	28.97	3/6/32	1.88
Austin	13	30.78	1/1/28	29.35	5/3/33	1.43
Baker	50	31.09	1/21/30	28.94	2/—/91	2.15
Baltimore	69	31.02	1/27/27	28.68	3/6/32	2.34
Binghamton	43	31.07	1/27/27	28.36	1/3/13	2.71
Birmingham	36	30.88	1/6/24	29.16	1/11/18	1.72
Bismarck	50	31.18	12/28/17	28.62	3/15/20	2.56
Block Island	59	30.98	2/1/20	28.20	3/7/32	2.78
Boise	40	31.13	1/21/30	29.12	4/26/37	2.01
Boston	69	31.03	2/1/20	28.45	4/7/32	2.58
Brownsville	17	30.88	1/5/24	28.02	9/5/33	2.86
Buffalo	69	31.03	1/26/27	28.74	1/3/13	2.29
Burlington	35	31.12	1/31/20	28.28	1/3/13	2.84
Cairo	39	31.00	1/5/24	28.92	2/27/02	2.08
Canton	33	31.08	1/31/20	28.20	1/3/13	2.88
Cape Henry	66	30.93	1/27/27	28.32	3/6/32	2.91
Charles City	35	31.02	1/26/27	28.95	*1/3/06	2.07
Charleston	69	30.83	1/2/99	28.78	3/6/32	2.05
Charlotte	62	30.91	1/2/99	28.94	3/6/32	1.97
Chattanooga	61	30.92	1/6/24	29.07	1/11/18	1.85
Cheyenne	68	31.05	12/9/98	28.89	3/14/20	2.16
Chicago	68	30.97	1/26/27	28.70	3/12/23	2.27
Cincinnati	67	30.93	*1/18/21	28.87	2/28/02	2.06
Cleveland	58	30.97	2/9/34	28.88	*1/12/18	2.09
Columbia, Mo	50	31.09	1/5/24	28.90	2/28/02	2.19
Columbia, S. C	53	30.85	1/19/21	28.80	3/6/32	2.05
Columbus	61	30.95	1/26/27	28.87	2/21/12	2.08
Concord	37	31.08	2/1/20	28.55	3/7/32	2.53
Concordia	54	31.11	1/25/05	28.81	3/29/24	2.30
Corpus Christi	53	30.93	1/5/24	28.65	9/14/19	2.28
Dallas		31.00	1/5/24	29.27	3/6/30	1.73
Davenport		31.02	12/20/24	28.69	2/28/02	2.33
Dayton	27	30.92	1/26/27	28.92	2/21/12	2.00
Del Rio		30.95	1/5/24	28.69	8/19/16	2.26
Denver	68	31.13	2/11/99	28.84	1/12/32	2.29
Des Moines	58	31.05	12/20/24	28.76	2/28/02	2.29
Detroit	69	31.04	2/9/34	28.82	1/12/18	2.22
Devils Lake	34	31.15	12/28/17	28.69	1/7/06	2.46
Dodge City	65	31.14	12/9/98	28.69	5/—/78	2.45
Dubuque	48	31.03	1/26/27	28.68	1/3/06	2.35
Duluth	58	31.05	1/26/27	28.75	3/16/20	2.30
Eastport	55	31.04	2/1/20	28.24	12/16/16	2.80
Elkins		31.00	1/2/99	28.87	1/12/18	2.13
El Paso		30.82	2/12/99	29.28	3/20/32	1.54
Erie	67	31.02	1/26/27	28.61	11/9/13	2.41
Escanaba	59	31.08	1/26/27	28.64	12/14/20	2.44
Eureka	51	30.71	12/9/23	28.93	2/2/15	1.78
Evansville	42	30.99	12/10/19	28.93	2/28/02	2.06
Fort Smith		31.04	1/5/24	29.04	2/13/19	2.00
Fort Wayne	28	30.97	1/26/27	28.93	2/25/26	2.04
Fort Worth	41	31.00	2/12/99	29.14	2/27/02	1.86
Fresno	53	30.64	*2/1/16	29.10	1/27/16	1.54
Galveston	69	30.90	1/6/24	28.55	9/8/00	2.35
Grand Junction	41	30.93	1/5/24	28.98	12/25/16	1.95
Grand Rapids	36	31.07	1/26/27	28.78	2/25/26	2.29
Green Bay		31.09	1/26/27	28.69	12/14/20	2.40
Greenville, S. C		30.84	1/19/21	29.05	1/11/18	1.79
Harrisburg	51	31.04	1/27/27	28.62	1/3/13	2.42
Hartford	35	31.06	2/1/20	28.04	9/21/38	3.02
Cape Hatteras	48	30.86	1/2/99	28.26	9/16/33	2.60
Havre	58	31.21	12/31/27	28.80	1/11/32	2.41
Helena	60	31.10	1/14/88	28.92	1/11/32	2.18
Houston		30.91	1/5/24	28.20	8/17/15	2.71
Huron	58	31.18	12/28/17	28.78	3/15/20	2.40
Indianapolis	69	30.95	12/10/19	28.78	2/28/02	2.17
Ithaca	40	31.03	1/27/27	28.84	1/12/18	2.19
Jacksonville	67	30.67	1/6/24	28.90	9/18/28	1.77
Kalispell	41	31.19	1/4/24	29.04	1/26/14	2.15
Kansas City	51	31.11	1/5/24	28.86	3/29/24	2.25
Keokuk	68	31.06	12/20/24	28.78	2/28/02	2.28
Key West	69	30.52	12/29/94	28.47	10/17/10	2.05
Knoxville	67	30.87	2/5/75	28.95	1/11/18	1.92
La Crosse	66	31.10	1/26/27	28.82	10/16/80	2.28
Lander	49	31.29	12/20/24	28.85	1/12/32	2.44
Lansing	30	31.04	2/9/34	28.81	2/25/26	2.23
Lincoln	43	31.08	1/25/05	28.78	3/29/24	2.30
Little Rock		30.98	1/5/24	28.93	2/27/02	2.05
Los Angeles		30.59	2/17/83	29.26	3/10/12	1.33
Louisville		30.98	*1/—/24	28.94	2/—/02	2.04
Lynchburg	20	30.96	1/27/27	28.90	1/3/13	2.06

TABLE 1.—*Extremes and range of pressure (in inches reduced to sea-level) for the period of record at Weather Bureau stations*—Con.

[Records include January 1940]

Station	Length of record	Highest	Date	Lowest	Date	Range
	Years	*Inches*	*M. D. Y.*	*Inches*	*M. D. Y.*	*Inches*
Macon	41	30.83	1/6/24	29.11	1/11/18	1.72
Madison	35	31.06	1/26/27	28.68	1/3/06	2.38
Marquette	50	31.08	1/26/27	28.63	12/14/20	2.45
Memphis	67	30.96	1/5/24	28.96	2/27/02	2.00
Meridian	50	30.89	1/6/24	29.22	1/11/18	1.67
Miami	29	30.51	*1/6/28	27.61	9/18/26	2.90
Miles City	48	31.26	2/11/99	28.86	2/6/00	2.40
Milwaukee	69	31.00	1/26/27	28.77	2/28/02	2.23
Minneapolis	25	31.00	1/26/27	28.78	3/15/20	2.22
Mobile	68	30.79	1/26/05	28.76	9/27/06	2.03
Modena	39	30.96	12/25/24	28.91	1/27/16	2.05
Montgomery		30.88	1/6/24	29.08	2/27/02	1.80
Moorhead	60	31.18	12/28/17	28.54	3/15/20	2.64
Nantucket	53	30.99	1/1/90	28.32	11/14/04	2.67
Nashville		30.97	1/5/24	29.02	2/27/02	1.95
New Haven	67	31.04	2/1/20	28.11	9/21/38	2.93
New Orleans	69	30.83	1/6/24	28.11	9/29/15	2.72
New York	58	31.01	1/27/27	28.38	3/1/14	2.63
Norfolk	40	30.96	2/28/34	28.35	3/6/32	2.61
Northfield	39	31.14	1/31/20	28.35	1/3/13	2.79
North Head	55	30.79	2/16/39	28.72	1/25/14	2.07
North Platte	65	31.13	1/14/27	28.79	5/8/27	2.34
Oklahoma City		31.06	1/5/24	29.00	2/26/02	2.06
Omaha	68	31.07	*1/25/25	28.82	3/29/24	2.25
Oswego		31.07	1/31/27	28.26	1/3/13	2.81
Palestine	58	30.97	1/5/24	29.13	2/27/02	1.84
Parkersburg	51	30.91	1/18/21	28.76	1/11/18	2.15
Pensacola	60	30.78	1/6/24	28.51	9/28/17	2.27
Peoria	36	31.01	12/20/24	28.89	3/11/23	2.12
Philadelphia	69	31.02	1/27/27	28.54	3/6/32	2.48
Phoenix	45	30.62	*12/24/89	29.32	5/18/02	1.30
Pittsburgh	67	30.97	2/9/34	28.82	1/12/18	2.15
Pocatello	41	31.04	1/21/30	29.06	1/28/28	1.98
Port Arthur	23	30.88	1/6/24	29.37	10/16/23	1.51
Portland, Maine	67	31.09	2/1/20	28.49	11/18/73	2.60
Portland, Oreg	68	30.83	2/2/80	28.56	1/9/80	2.27
Providence	26	31.02	2/1/20	28.51	3/1/14	2.51
Pueblo	51	31.02	1/14/27	28.87	2/7/37	2.15
Raleigh	53	30.95	*1/2/99	28.57	3/6/32	2.38
Rapid City	52	31.15	2/11/99	28.92	3/14/20	2.23
Reading		31.02	2/1/20	28.62	1/3/13	2.40
Redding	11	30.63	1/23/38	29.31	2/9/38	1.32
Reno	34	30.92	1/3/19	29.00	1/27/16	1.92
Richmond	42	31.00	1/2/99	28.58	3/6/32	2.42
Rochester	69	31.05	1/31/20	28.48	1/3/14	2.57
Roseburg	62	30.78	2/16/39	28.92	2/2/15	1.86
Roswell	45	30.83	2/22/11	29.19	3/20/32	1.64
Sacramento	62	30.74	2/17/83	28.95	1/27/16	1.79
St. Joseph		31.06	1/5/24	28.83	3/29/24	2.23
St. Louis	40	31.01	12/20/24	28.86	2/28/02	2.15
Salt Lake City	51	31.03	1/17/88	29.03	1/12/32	2.00
San Antonio	55	30.96	1/5/24	28.67	8/20/86	2.29
San Diego	68	30.53	2/17/83	29.46	3/9/12	1.07
Sandusky	61	31.01	1/26/27	28.80	1/11/18	2.21
Sandy Hook	24	31.00	2/1/20	28.44	3/6/32	2.56
San Francisco	48	30.64	3/—/02	28.85	1/27/16	1.79
Santa Fe		30.84	1/18/88	29.03	12/—/76	1.81
Sault Ste. Marie	52	31.15	1/26/27	28.58	11/29/19	2.57
Savannah		30.75	1/2/99	28.86	3/6/32	1.89
Scranton	39	31.08	1/27/27	28.76	1/3/13	2.32
Seattle	46	30.83	12/3/21	28.80	1/25/14	2.03
Sheridan	32	31.11	12/31/27	28.89	1/12/32	2.22
Shreveport	67	30.95	1/5/24	29.21	8/23/79	1.74
Sioux City	50	31.09	*1/25/05	28.85	3/15/20	2.24
Spokane	59	31.04	1/4/24	28.93	1/25/14	2.11
Springfield, Ill	51	31.00	1/15/88	28.82	3/11/23	2.18
Springfield, Mo	52	31.03	1/5/24	28.93	*2/27/02	2.10
Syracuse	37	31.06	12/29/33	28.29	1/3/13	2.77
Tacoma	42	30.82	12/3/21	28.77	1/25/14	2.05
Tampa		30.64	12/29/94	28.81	10/25/21	1.83
Tatoosh Island	50	30.80	12/3/21	28.62	1/25/14	2.18
Terre Haute		30.97	12/20/24	28.99	3/11/23	1.98
Toledo	67	31.04	1/26/27	28.88	1/12/18	2.16
Trenton	26	30.98	*1/31/20	28.51	3/6/32	2.47
Valentine	51	31.15	12/11/98	28.79	3/14/20	2.36
Vicksburg		30.95	1/6/24	29.06	2/27/02	1.89
Walla Walla	54	31.07	1/21/30	29.03	1/25/14	2.04
Washington, D. C	67	31.01	1/27/27	28.67	3/6/32	2.34
Wichita	51	31.09	1/5/24	28.88	3/29/24	2.21
Williston	61	31.20	2/11/99	28.91	1/10/80	2.29
Wilmington, N. C	69	30.91	1/2/99	28.65	3/6/32	2.26
Winnemucca	62	31.04	1/17/88	28.93	1/27/16	2.11
Wytheville		30.89	2/28/34	29.08	1/11/18	1.81
Yakima	11	30.90	11/22/30	29.07	11/16/30	1.83
Yellowstone Park	36	31.15	12/20/24	28.96	1/12/32	2.19
Yuma	60	30.64	1/24/38	29.37	5/8/02	1.27

*Also on later dates.

RELATION BETWEEN EQUIVALENT POTENTIAL TEMPERATURE AND WET-BULB POTENTIAL TEMPERATURE

By H. H. BINDON

[Meteorological Service of Canada,[1] July 1939]

The wet-bulb potential temperature and the equivalent potential temperature have both been regularly employed in air-mass analysis as an identification invariant for air undergoing pseudoadiabatic changes; and since there is an underlying relation between these two quantities, it appears worth while to derive the equation for transforming one into the other.

The following notation will be used:

w = mixing ratio in grams of water vapor per gram of dry air;
y = number of grams of liquid water per gram of dry air;
$\xi = w + y$;
T = air temperature;
T_w = wet-bulb temperature;
θ_d = partial potential temperature;
θ_e = equivalent potential temperature (1), (2);
θ_w = wet-bulb potential temperature;
T_c = temperature at the condensation level;
e_m = water-vapor pressure (since saturation is assumed, this is the maximum vapor pressure);
p_d = partial pressure of dry air;
p_c = pressure at condensation level;
c_p = specific heat of dry air (0.240 cal/gm);
L = latent heat of condensation of water vapor;
$L = 594.9 - 0.51t$ (3);
c = specific heat of liquid water;
A = reciprocal of the mechanical equivalent of heat, (2.392×10^{-8});
R = gas constant for dry air (2.87×10^6 c. g. s. units).

The equation for the equivalent potential temperature as derived by Rossby (4) is:

$$\theta_e = \theta_d e^{\frac{L_c w}{c_p T_c}}, \tag{1}$$

where L_c = latent heat of condensation at temperature T_c. The equation for the saturated adiabatic (5) is:

$$ln\ p_d - \frac{c_p + \xi c}{AR} ln\ T - \frac{Lw}{ART} = k, \tag{2}$$

where k is a constant.

The partial potential temperature is given by:

$$\frac{c_p}{AR} ln\left(\frac{\theta_d}{T}\right) = ln\left(\frac{1000}{p_d}\right). \tag{3}$$

Substituting this value for $ln\ p_d$, equation (2) becomes:

$$\frac{c_p}{AR} ln\ \theta_d + \frac{\xi c}{AR} ln\ T + \frac{Lw}{ART} = \text{constant}. \tag{4}$$

In pseudoadiabatic ascent, the second term in (4) is neglected, so that the equation for the pseudoadiabatic is given by:

$$ln\ \theta_d + \frac{Lw}{c_p T} = \text{constant}. \tag{5}$$

If the air is not saturated at the beginning, the temperature T in (5) has to be replaced by the condensation temperature T_c while w of course remains the same until condensation sets in. Then:

$$ln\ \theta_d + \frac{Lw}{c_p T_c} = \text{constant}. \tag{5a}$$

According to Rossby's definition (2), the equivalent potential temperature is obtained on the assumption that the air mass ascends pseudoadiabatically until the mixing ratio vanishes, $w = 0$. The value of θ thus arrived at is the equivalent potential temperature θ_e. It follows that:

$$ln\ \theta_e = \text{constant}, \tag{6}$$

where the constant is the same as in equation (5). Equating these two expressions leads to equation (1). The derivation of this equation has been repeated here, since some of the equations will be used to establish the relation between equivalent potential and wet bulb potential temperature.

The wet bulb potential temperature of a mass of air has been defined by Normand (6) as the temperature attained by a mass of air brought adiabatically to saturation and then carried pseudoadiabatically to a pressure of 1,000 mb. In figure 1, the connection between temperature, pressure, mixing ratio, wet-bulb temperature, wet-bulb potential temperature, and equivalent-potential temperature on a tephigram is recapitulated. In the example it is assumed that the air has originally a pressure of 900 mb., a temperature of 10° C. and a relative humidity of 65 percent. Since the saturation mixing ratio at $p = 900$ mb. and $T = 10°$ C. is 8.5 gm/kg as shown by the tephigram, the actual mixing ratio is $w = 5.5$ gm/kg. Similarly the maximum vapor pressure is 12.3 mb., and the actual one 8 mb. To find the pressure p_c and temperature T_c at the condensation level, the point $p = 900$ mb., $T = 10°$ C. has to be moved along the dry adiabatic to the intersection with the mixing ratio line 5.5 gm/kg. The pressure and temperature are here 820 mb. and 2.3° C. If the particle is moved along the pseudoadiabatic until it reaches its original pressure of 900 mb., its wet-bulb temperature is found to be 6.5° C. By bringing the particle still further down along the pseudoadiabatic until it reaches the pressure 1,000 mb., its wet-bulb potential temperature is found to be 11° C.

The equivalent potential temperature is obtained by following the pseudoadiabatic from the condensation point to a pressure as low as is possible on the thermodynamic chart used. On the tephigram used here, for example, the pseudoadiabatic is quite closely tangential to the dry adiabatic at a pressure of 380 mb. Strictly speaking, the particle should be brought to the pressure zero to ensure that all the water vapor is precipitated. However, it is obviously sufficient in the example chosen here to bring the particle only to 380 mb. pressure. From this position the particle has to be moved dry adiabatically to the standard pressure 1,000 mb. The temperature reached here is the equivalent potential temperature. In the present example it is 34° C.

Instead of using this graphical method for determining the equivalent potential temperature which corresponds to a given wet-bulb potential temperature, a formula can be derived to express the relation between the two quantities. To obtain the wet-bulb potential temperature on the thermodynamic chart the air mass had to be moved *pseudo*adiabatically from the condensation point p_c, T_c, to the pressure 1,000 mb., since the wet bulb is being con-

[1] Published by permission of the Controller, Meteorological Division, Air Services Branch, Department of Transport.

sidered. At this pressure of 1,000 mb. it assumes the wet-bulb potential temperature θ_w while its mixing ratio is given as the saturation mixing ratio at the temperature θ_w, $w(\theta_w)$. Therefore, equation (5) can be applied:

$$ln\ \theta_w+\frac{Lw(\theta_w)}{c_p\theta_w}=\text{constant}. \tag{5b}$$

The constants on the right of (5b) and (5a) are equal since the points p_c, T_c, and 1,000 mb., θ_w, lie on the same pseudoadiabatic. The constant is furthermore, according to equation (6), equal to $ln\ \theta_e$ so that

$$ln\ \theta_e=ln\ \theta_w+\frac{Lw(\theta_w)}{c_p\theta_w},$$

or

$$\theta_e=\theta_w e^{\frac{Lw(\theta_w)}{c_p\theta_w}}. \tag{7}$$

(It should be noted that the saturation mixing ratio $w(\theta_w)$ has to be taken at a pressure of 1,000 mb., as is obvious from the preceding derivation.) By substituting for the mixing ratio the vapor pressure e_m, which is given to an accuracy sufficient for our purpose by

$$w=0.622\frac{e_m}{1000}, \tag{8}$$

equation (7) may be transformed into

$$\theta_e=\theta_w e^{\frac{Le_m(0.622)}{c_p 1000\theta_w}}. \tag{9}$$

Since the exponent of the exponential function is small, it may be developed into series, and terms of a higher order than the first omitted without serious loss of accuracy in most cases.

Equation (7) becomes thus

$$\theta_e=\theta_w+\frac{Lw(\theta_w)}{c_p}. \tag{7a}$$

$Lw(\theta_w)$ is the latent heat contained in the air due to the presence of water vapor saturated at the temperature θ_w. Thus equation (7a) states that the equivalent potential temperature is equal to the wet-bulb potential temperature plus the increase which could be caused by the latent heat of the saturated water vapor contained in the air at the wet-bulb potential temperature. Equation (9) can be written

$$\theta_e=\theta_w+\frac{(0.622)Le_m(\theta_w)}{c_p\ 1000}. \tag{9a}$$

This relation may also be obtained directly from the psychrometer equation (7) $e_m(T_w)-e=Bp(T-T_w)$, where e is the actual vapor pressure of the air, and

$$B=\left(1-\frac{e_m(T_w)}{p}\right)\frac{c_p}{L(T_w)(0.622)}.$$

If the air of pressure p, temperature T, and vapor pressure e is brought pseudoadiabatically to an infinitely small pressure, so that $e=0$ since all the water vapor condenses and falls out, and is then carried adiabatically to the standard pressure of 1,000 mb., T changes into θ_e while T_w becomes θ_w. Thus the psychrometer equation changes into

$$e_m(\theta_w)=B(1000)(\theta_e-\theta_w), \text{ or}$$

$$\theta_e=\theta_w+\frac{e_m(\theta_w)}{B(1000)};$$

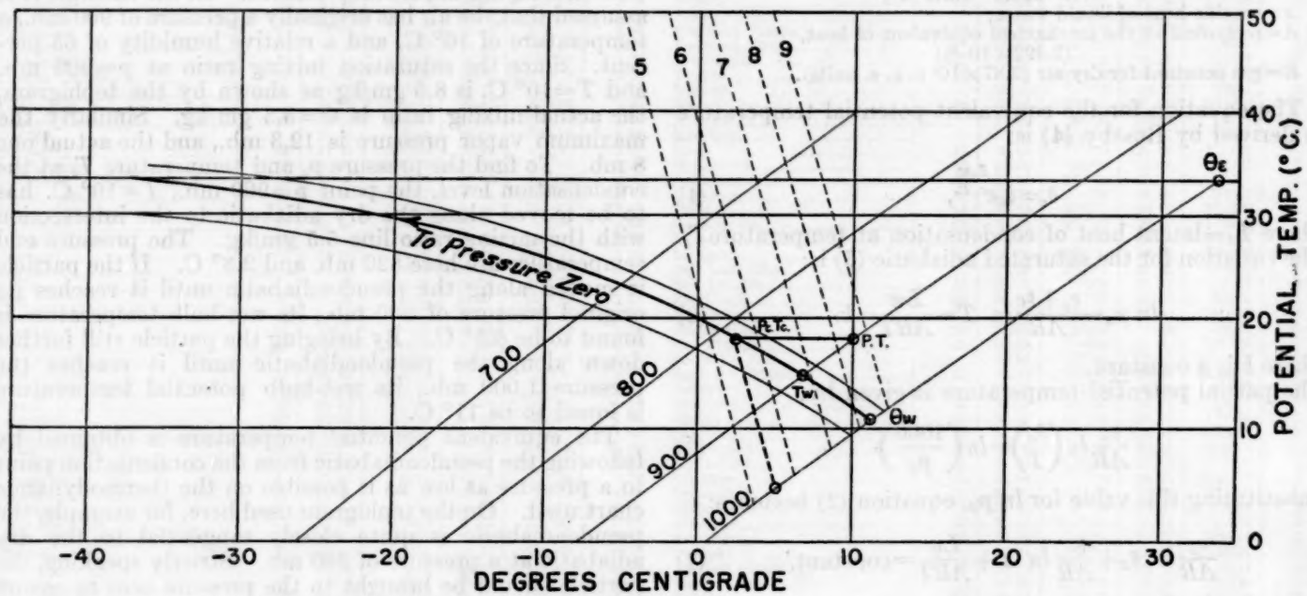

FIGURE 1.

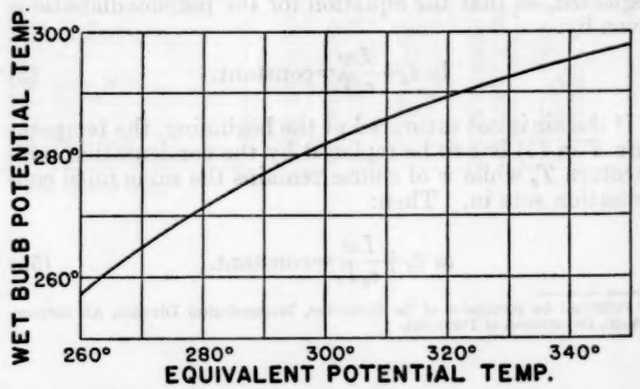

FIGURE 2.—Relation between equivalent potential and wet-bulb potential temperature.

since in B the expression $\frac{e_m(\theta_w)}{p}$ is very much less than unity, this is practically identical with (9a).

From equation (9) the following numerical relation between the equivalent potential temperature θ_e and the wet-bulb temperature θ_w is found:

θ_e	260°	270°	280°	290°	300°	310°	320°	330°	340°	350°
θ_w	257.2	264.6	271.3	276.8	281.7	285.9	289.4	292.5	295.3	297.8

The relation is represented graphically in figure 2.

Thus the use of θ_e or θ_w to identify a mass of moist air undergoing pseudoadiabatic changes is a matter of personal choice. The wet-bulb potential temperature appears to have a certain conceptual advantage since it does not require the air to be taken to zero pressure for extraction of its precipitable water. Moreover, the wet-bulb potential temperature is closely related to the wet bulb temperature, a quantity which can be easily measured.

REFERENCES

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(2) C.-G. Rossby, *M. I. T. Met. Papers*, Vol. 1, No. 3 (1932).
(3) D. Brunt, *Physical and Dynamical Meteorology*, Cambridge, p. 406 (1934).
(4) *l. c.* (2) equation 26, page 10.
(5) *l. c.* (3) equation 11, page 54.
(6) Normand, *Mem. Indian Met. Dept.*, No. 23 (1921).
(7) *l. c.* (3), equations 38, 39, page 82.

TROPICAL DISTURBANCES OF SEPTEMBER 1940

By J. H. GALLENNE

[Weather Bureau, Washington, Nov. 2, 1940]

August 30–September 3.—The first indications of probable origin of this hurricane appeared on the morning of August 30, as a mild depression central about 225 miles off the Florida east coast. A slow progressive movement toward the north-northwest with rapid development, was indicated by the report of an unidentified vessel near 32°12′ N., and 72°24′ W., at 5 p. m. of that day, which recorded an east-southeast wind, force 10, with barometer reading of 978.7 millibars (28.90 inches). During the next day the disturbance was attended by severe squalls and strong shifting gales over a large area and by winds of hurricane strength near its center. Shortly after the morning observation of September 1, the course of the disturbance seems to have changed from north-northwest to north-northeast.

The American S. S. *Dungannon* reported that she encountered north-northeast winds, force 10, at 8 a. m. of September 1, near 35°50′ N., and 73°45′ W., with pressure reading 993 millibars (29.32 inches), and that the wind shifted to northwest and increased to force 12 shortly thereafter. During the evening of the same day, the tanker *Franklin K. Lane*, on a voyage from New York to Corpus Christi, reported that she met an east-southeast hurricane which shifted to west-northwest near 38°17′ N., and 70° 32′ W. She also reported that a pressure reading of 965.1 millibars (28.50 inches) was noted during the passage of the hurricane. This is the lowest barometer reading of record in connection with the disturbance. Several other vessels reported winds of force 8 or higher, on the 1st. (See Table of Ocean Gales and Storms on page 255 in this REVIEW.)

The disturbance was centered at 7:30 a. m., September 2, about 75 miles east-northeast of Nantucket, Mass., moving rapidly north-northeastward. The Weather Bureau office, Nantucket, Mass., recorded a maximum velocity, for a 5-minute period, of 57 miles an hour, from the northeast and an extreme velocity of 65 miles an hour on September 2. This exceeds all previous September wind records at that station.

The storm moved inland a short distance to the northwest of Yarmouth, Nova Scotia, with rapidly diminishing intensity, during the evening of the 2d, and apparently dissipated in the region north of Anticosti Island, Quebec, on September 3.

Timely warnings and advisories were issued from the forecast center at Washington, D. C., covering the movement of this hurricane.

September 11–18.—On the 7:30 a. m. chart of September 11, 1940, there were some indications of a disturbance of slight intensity about 250 miles northeast of St. Thomas, V. I., moving in a west-northwesterly direction. During that afternoon, an unidentified vessel near latitude 20° N., and longitude 64°30′ W., reported cloudy weather, northwest wind, force 6, with a barometric pressure reading 1,007 millibars (29.74 inches).

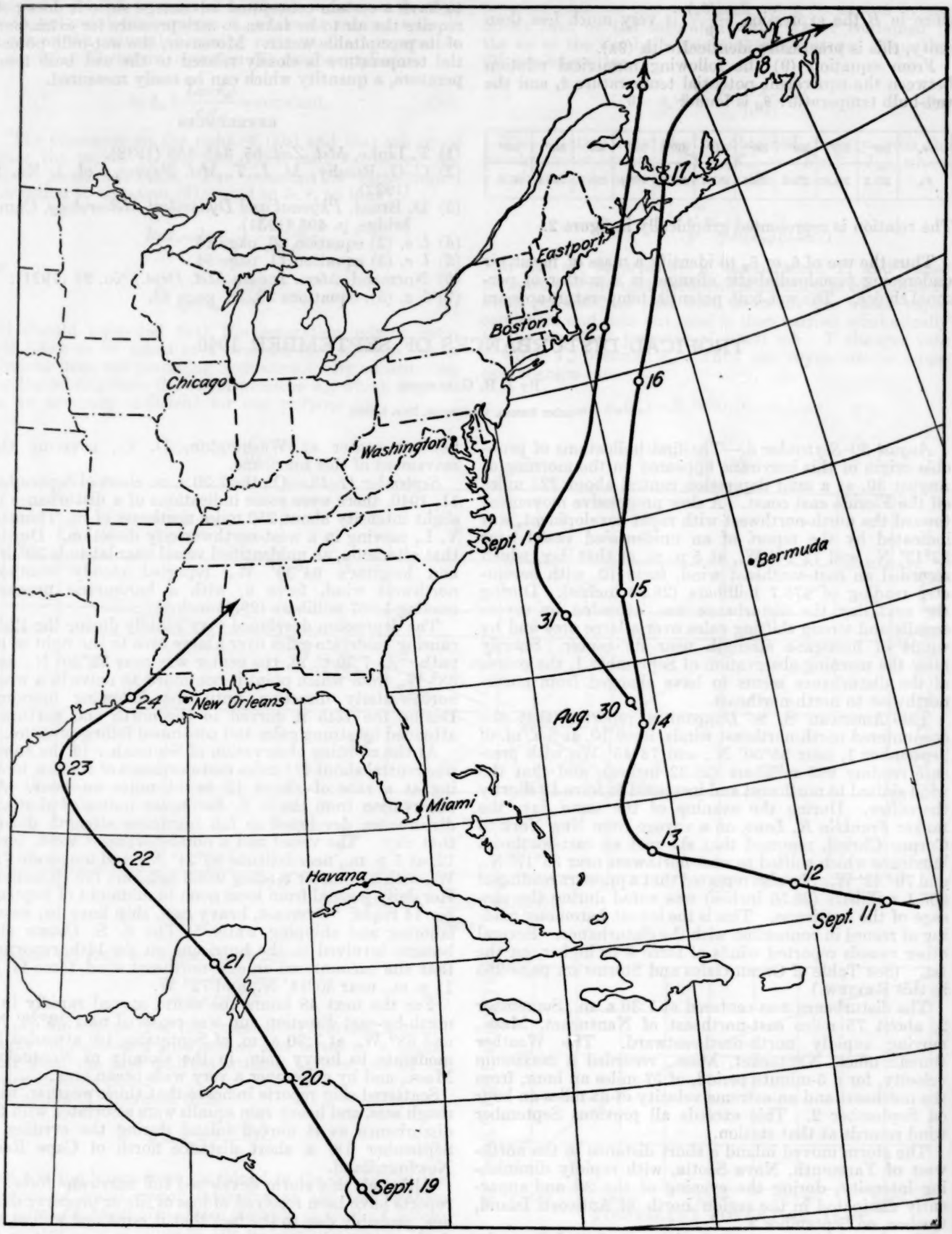
The depression developed very rapidly during the 12th, causing moderate gales over a large area to the right of its path. At 7:30 p. m. the center was near 22°30′ N., and 68° W., from which point it continued to move in a west-northwesterly direction until the following morning. During the 13th it curved to the north and northeast attended by strong gales and continued falling pressure.

At the morning observation of September 14 the storm was central about 475 miles east-northeast of Nassau, moving at a rate of about 12 to 14 miles an hour. An observation from the S. S. *Borinquen* indicated that the disturbance developed to full hurricane strength during that day. The vessel met a north-northeast wind, force 12, at 5 p. m., near latitude 30°24′ N., and longitude 71° W., with barometer reading 988.3 millibars (29.19 inches). Her daily journal from local noon to midnight of September 14 reads: "Overcast, heavy rain, ship hove to; vessel laboring and shipping water." The S. S. *Coamo* also became involved in the hurricane on the 14th, reporting that she encountered an east-northeast wind, force 11, at 11 p. m., near 30°14′ N., and 72° W.

For the next 48 hours the storm moved rapidly in a north-by-east direction and was centered near 39°30′ N., and 68° W., at 7:30 a. m. of September 16, attended by moderate to heavy rain, in the vicinity of Nantucket, Mass., and by gales over a very wide ocean area.

Scattered ship reports indicate that thick weather, with rough seas, and heavy rain squalls were associated with the disturbance as it moved inland during the evening of September 18, a short distance north of Cape Race, Newfoundland.

Although this storm developed full hurricane force, no reports have been received of loss of life or property damage, probably due to the fact that it remained well at sea during practically its entire passage.



Tracks of tropical disturbances in September 1940.

The movements of this hurricane were amply covered by advisories and warnings issued by the Weather Bureau.

September 19–24.—A rather weak tropical disturbance, 1,006 millibars (29.71 inches), formed on the morning of September 19, 1940, in the vicinity of Bluefields, Nicaragua. It progressed in a northwestward direction over the Gulf of Honduras during the next 24 hours and moved inland over Quintana Roo during the night of September 20. By the afternoon of September 21 the depression had entered the Gulf of Mexico, northwest of Progresso. Yucatan, attended by winds of force 4–5 (Beaufort Scale).

The disturbance continued to move northwestward increasing slowly in intensity after passing into the Gulf of Mexico. On the morning of September 23, it was centered near latitude 27°45′ N., and longitude 95°30′W. An unidentified vessel in the western portion of the Gulf of Mexico at 5 a. m. of the 23d, encountered a fresh gale from the northwest. That afternoon, the depression moved very slowly and curved rather sharply to the northeast. The tanker *Dannedaike* met a fresh southwest gale near 28° N., and 95° W., at 7 p. m. of the 23d, with the lowest pressure reading of the storm, 1,004 millibars (29.65 inches).

During the early morning of September 24 the disturbance passed inland over southwestern Louisiana, a short distance to the west of Lafayette. Heavy rains were associated with this storm over southern Louisiana and along the upper coast to Texas, the heaviest amount reported being 7.10 inches at Cheneyville, La.

The depression, decreasing in intensity after passing inland, continued to move northeastward and merged with a low-pressure trough which dominated the south-central and eastern portions of the United States, during the evening of September 24.

Advisories and warnings were issued by the forecast center at New Orleans, La., from September 21, when the disturbance entered the Gulf of Mexico, until it moved inland and diminished rapidly on the 24th.

A diagram showing the tracks of these disturbances appears herewith.

METEOROLOGICAL AND CLIMATOLOGICAL DATA FOR SEPTEMBER 1940

[Climate and Crop Weather Division, J. B. KINCER in charge]

AEROLOGICAL OBSERVATIONS

By EARL C. THOM

The mean surface temperatures during September (chart I) were above normal over the western and north-central parts of the United States, and but slightly below normal over most of the rest of the country. A considerable area in the north central and extreme north portions of the country averaged 6° F., or more, above normal with the maximum positive departure of about 8° F. occurring in scattered areas of Montana and northeastern Wyoming. In three small widely scattered areas of the east and south temperatures for the month were 4° F. below normal.

At the 1,500 m. level the direction of the 5 a. m. resultant wind for the month (chart VIII) was north of the corresponding normal resultant (clockwise turning) over all of the eastern half of the country and at San Diego with the opposite departure from normal direction over the rest of the country. At the 3,000 m. level (chart IX) the same general departure of the 5 a. m. resultant direction from normal was noted except that the counter clockwise turning from normal was also noted at Houston and at Key West. At 5,000 meters the 5 p. m. resultant direction (chart X) when compared to the 5 a. m. normals at that level show southward turning from normal in the area west of a line from Duluth to El Paso, while all stations east of this line, except Arlington, show resultants more northerly than normal.

The 5 a. m. resultant velocities for the month were above the corresponding normal in the southwest and extreme west parts of the country at the 1,500 m. level and were generally below normal over the rest of the country. The resultant velocities were about 3 m. per second above normal along the California coast and averaged about 3 m. per second below normal over the northern Great Lakes and the extreme north central region. At the 3,000 m. level the 5 a. m. resultant velocities were below normal over most of the northern half of the country and were generally above normal to the southward. At the 5,000 m. level the September 5 p. m. resultant velocities were considerably above the corresponding 5 a. m. normals over most of the country.

Reference to chart I indicates that the mean temperatures in the area west of a line drawn across the United States through St. Louis, Mo., and Abilene, Tex., were above normal for September while temperatures in the rest of the country were below normal. This division of the country corresponds closely to the corresponding northward and southward departures from normal of the resultant directions for the month at the 1,500 m., 3,000 m., and 5,000 m. levels.

In September the directions of the 5 p. m. resultant winds at 1,500 meters were north of the corresponding 5 a. m. resultants at this level over the northwest and the Rocky Mountain region while, except at two stations, the resultant winds turned to the southward during the day over the rest of the country. At the 3,000 m. level the resultant winds turned to the northward during the day over the western one-third of the country and turned to the southward over the central one-third while the shifts were well distributed at this level over the Eastern States.

At the 1,500 m. level the resultant velocities at 5 p. m. for the month were higher than the corresponding 5 a. m. velocities over about half of the country, including New England, the extreme Northern States, the Southwest and and most of the South Central and Gulf Coast States. At 3,000 m. the change in resultant velocities from 5 a. m. to 5 p. m. were again well distributed, the velocities in the evening being higher than the morning velocities over the New England States, over Florida, and over most of the central and west central region.

The upper air wind data discussed above are based on 5 a. m. observations (charts VIII and IX) as well as on observations made at 5 p. m. (table 2, charts X and XI).

At all 1,000 m. levels from 4,000 m. up to 18,000 m. above sea level the highest pressures observed over the country (table I) occurred on or near the southwest boundary line of the United States, the maximum pressure at each of these levels being recorded at one or more of the three stations Brownsville, El Paso, or Phoenix. The lowest pressure over the United States at each 1,000 m. level from 4,000 m. to 17,000 m., occurred at Sault Ste. Marie. At 3,000 m. the same minimum pressure (707 mb.) occurred at Sault Ste. Marie as at several other stations, while at 18,000 m. a low pressure reading of 78

mbs. occurred at eight stations, including Sault Ste. Marie.

Mean pressures at the three levels, surface, 500 m., and 1,000 m. were lower in September than in August this year over the extreme West, the Great Lakes, the Northeast, and over the East Central States, while pressures were higher over the rest of the country at these levels. Except for several small pressure increases in the Central States at the lower levels, all September mean pressures were lower than in August over the United States from 1,500 m. up to at least 14,000 m. This decrease in pressure was especially marked along the Pacific coast and along the North Atlantic coast, for example, the average decrease in pressure for these levels was 6 mb. at both Medford and Lakehurst while a decrease of 9 mb. was noted at Medford at both the 8,000 m. and 11,000 m. levels.

A difference of 15 mb. between the highest and the lowest mean pressure was observed in September at the five 1,000 m. levels from 7 to 11 km. Steep pressure gradients were noted between Sault Ste. Marie and Joliet at the 8- and 9-km. levels and between San Diego and Phoenix at the three levels, 8, 9, and 10 km.

Temperatures were lower in September this year than in August at all levels below 11,000 m. At the 13,000 m. level temperatures over all stations in the western one-third of the country as well as over Sault Ste. Marie and over Lakehurst were higher than in August. At the next five higher 1,000 m. levels temperatures were in general lower than in August over the central one-third of the country and higher over the rest of the United States. At 15,000 m. for example, the mean temperature for September was 4.8° C. higher than in August at Medford, 4.2° higher at Lakehurst, and 2.4° lower at Omaha.

Considering the temperatures for all levels over the country as a whole September was colder in 1940 than in 1939. Except at Bismarck, Denver, and Phoenix stations reported mean temperatures lower than those for September 1939 at the four lower levels, 1,000 m., 2,000 m., 3,000 m., and 4,000 m. At most of the 1,000 m. levels from 5,000 to 11,000 m. the mean temperatures were still lower than last year except at the same three stations. Above 11,000 m. up to at least 17,000 m., the mean temperatures were generally higher than in 1939.

The altitude of the mean temperature of 0° C. was 4,900 m. over Brownsville in September and was 3,100 m. over Sault Ste. Marie. The altitude of this level was on the average 4,500 m. or higher at all Weather Bureau stations in the United States south of 35° N. latitude. The level of freezing temperatures in the free air was lower than in August; being 1,200 m. lower at Medford, 800 m. lower at Lakehurst, but only 100 or 200 m. lower than in August over the central part of the country.

All stations have this month reported absolute minimum temperatures as observed in free air to the nearest tenth of a degree, as well as the level at which this minimum was recorded and the date on which it occurred. The minimum temperature for the month reported by Weather Bureau stations was −79.8° C. (−112° F.) reported as occurring on September 25 at 15.3 km. (about 9.5 miles) above Brownsville, Tex. The highest minimum temperature for the United States during September was reported on September 22 as −60.5° C. (−77° F.) at an altitude of 15.6 km. over Seattle, Wash.

Table 3 shows the maximum free air wind velocities and their directions for various sections of the United States during September as determined by pilot-balloon observations. The extreme maximum for the month was 78.0 m. per second (174 m. p. h.) observed over San Antonio, Tex. on September 12. This high velocity wind was blowing from the WNW. at an elevation of 21,230 m. (about 13 miles) above sea level. A maximum 57.6 m. per second for the month of September occurred last year over Cleveland, Ohio, at 12,400 m. above sea level. It is noted that as far as was determined by pilot-balloon observations the maximum free air wind velocity was higher in September 1940 than it was in this month during the years 1937, 1938, and 1939 and that this was true both in the free-air layer from 2,500 meters to 5,000 m. and in the free air above 5,000 m.

Tropopause data for September showing the mean altitude and temperature of the tropopause at various stations are shown in table 4 and on chart XIII.

MEAN ISENTROPIC CHART [1]

The circulation for September 1940 was dominated by a major anticyclonic eddy central over the Plains States. Within the major vortex three distinct tongues, two moist and one dry, appeared. The major eddy showed above normal intensity and covered a large area, thus displacing the dry anticyclonic tongue east of its normal position and causing below normal precipitation over the Southeastern States.

Surface temperature departures were in general positive below the northward-moving currents and negative below the southward-moving currents. The large positive precipitation departures over the Western States are typical of the left side of a well-developed moist tongue, whereas the deficiencies over northern Missouri and southern Iowa apparently were due to the splitting of the moist tongue. The southern branch of the moist tongue probably showed its most pronounced development in the early part of the month when flood rains occurred in southeastern Kansas and northeastern Oklahoma. The isohyets for this storm showed a definite NW.-SE. orientation with a center of 19.75 inches near Hallett, Okla.

[1] Prepared by A. K. Showalter, Hydrometeorological Section.

TABLE 1.—*Mean free-air barometric pressure in millibars, temperature in degrees Centigrade, and relative humidities in percent, obtained by airplanes and radiosondes during September 1940*

Altitude (meters) m. s. l.	Brownsville, Tex. (6 m.)				Bismarck, N. Dak. (505 m.)				Charleston, S. C. (14 m.)				Denver, Colo. (1,616 m.)				El Paso, Tex. (1,193 m.)				Ely, Nev. (1,908 m.)				Great Falls, Mont. (1,117 m.)			
	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity
	Stations and elevations in meters above sea level																											
Surface	30	1,014	23.3	85	30	958	14.7	76	30	1,015	19.7	88	29	841	15.6	78	30	883	22.5	48	30	810	11.3	65	30	890	15.4	64
500	30	958	21.9	83					30	960	20.4	70																
1,000	30	905	19.0	76	30	904	18.4	56	30	906	18.2	68																
1,500	30	853	16.9	67	30	852	16.1	54	30	854	15.4	71					30	853	22.8	47					30	851	15.0	59
2,000	30	804	14.4	61	30	803	13.5	50	30	805	12.7	66	29	804	16.0	64	30	804	19.6	49	30	801	12.4	61	30	802	12.0	60
2,500	30	758	11.8	60	30	756	10.8	48	30	758	10.4	62	29	758	13.8	60	30	759	16.0	52	30	755	11.4	54	30	755	8.6	64
3,000	30	714	9.0	54	30	712	7.8	48	30	714	7.9	59	29	714	10.7	60	30	715	12.1	57	30	711	7.7	55	30	710	5.3	65
4,000	30	632	4.2	43	29	630	1.2	49	30	632	2.9	42	29	632	3.6	70	30	634	4.4	68	29	629	−0.3	63	30	628	−1.2	65
5,000	30	559	−0.4	39	29	556	−5.5	47	30	558	−2.5	33	28	558	−3.7	78	30	560	−2.3	70	29	554	−6.8	63	29	553	−7.6	66
6,000	29	493	−6.0	35	28	489	−11.8	44	30	491	−8.6	30	28	491	−9.9	72	29	493	−7.1	61	29	487	−12.9	55	29	486	−14.1	61
7,000	28	433	−12.5	33	28	428	−18.9	42	30	431	−15.5	30	28	430	−16.3	61	29	434	−13.3	54	29	427	−20.1	49	29	425	−21.4	58
8,000	28	379	−19.4	31	27	373	−26.7	41	30	377	−22.7	30	27	376	−23.6	55	29	379	−20.6	50	29	372	−28.1	50	29	370	−29.2	57
9,000	28	330	−26.6	29	27	324	−34.4	41	29	328	−30.1	30	27	327	−31.3	52	29	330	−28.1	49	29	323	−35.8	49	29	321	−37.3	57
10,000	28	287	−34.2	29	27	280	−42.2		29	284	−37.8		26	284	−39.3	51	29	287	−35.7	49	29	280	−43.1		28	278	−45.0	
11,000	27	248	−41.6		26	241	−49.4		28	245	−45.5		26	244	−46.9		29	248	−43.0		28	240	−49.1		28	238	−51.3	
12,000	27	214	−48.6		26	207	−55.2		27	211	−52.4		25	210	−52.8		29	214	−50.0		28	206	−53.3		28	204	−54.7	
13,000	27	183	−55.7		26	176	−58.0		27	180	−58.6		25	179	−57.6		29	183	−56.9		27	176	−56.5		28	175	−56.6	
14,000	27	156	−62.4		26	150	−59.4		27	153	−63.5		24	153	−61.3		28	156	−63.1		27	150	−59.0		26	149	−57.9	
15,000	26	133	−67.8		26	127	−60.5		26	130	−66.4		24	130	−64.7		28	132	−68.5		26	128	−61.1		26	127	−58.7	
16,000	26	112	−71.0		25	109	−61.2		25	111	−67.9		24	110	−66.0		27	112	−72.0		26	109	−62.4		25	108	−59.6	
17,000	24	95	−71.5		20	92	−61.2		23	94	−67.8		24	93	−66.1		27	94	−71.5		24	93	−62.5		23	92	−59.8	
18,000	22	80	−69.7		20	78	−60.3		21	79	−65.8		22	79	−64.3		24	80	−68.3		22	79	−61.4		21	78	−60.6	
19,000	19	68	−66.2		18	67	−59.2		21	67	−63.8		22	67	−61.9		23	68	−64.9		19	67	−59.7		18	67	−59.0	
20,000	12	57	−62.8		16	57	−57.9		18	57	−61.1		17	57	−60.1		15	57	−61.6		17	57	−58.3		11	56	−58.4	
21,000	7	48	−60.6		10	48	−56.6		9	48	−59.5		12	48	−58.7		5	49	−59.7		10	48	−57.1					
22,000	5	41	−57.7										10	41	−57.4													
23,000													5	35	−55.6													

Altitude (meters) m. s. l.	Joliet, Ill. (178 m.)				Lakehurst, N. J.[1] (39 m.)				Medford, Oreg. (401 m.)				Nashville, Tenn. (180 m.)				Norfolk, Va.[1] (10 m.)				Oakland, Calif. (2 m.)				Oklahoma City, Okla. (391 m.)			
	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity
	Stations and elevations in meters above sea level																											
Surface	29	998	13.7	85	30	1,012	13.1	91	29	966	16.5	72	30	996	17.7	76	25	1,019	19.3	87	30	1,013	17.0	80	30	972	19.4	72
500	29	961	16.9	65	30	958	14.7	67	29	935	16.8	68	30	960	19.6	66	25	962	18.9	70	30	956	15.2	79	30	960	20.2	65
1,000	29	906	14.0	65	30	903	12.0	62	29	900	14.9	66	30	906	17.0	65	25	908	15.5	69	30	901	14.2	65	30	906	19.3	57
1,500	29	853	10.7	69	30	851	8.7	63	29	849	11.9	71	30	854	13.5	68	25	855	12.3	64	30	849	12.3	58	30	855	17.0	56
2,000	29	804	8.5	58	30	800	5.8	59	29	799	8.9	75	30	805	11.0	63	25	806	9.7	55	30	800	9.8	54	29	806	14.4	55
2,500	29	756	6.6	47	30	752	4.0	45	29	752	5.6	72	30	758	8.6	58	25	759	7.3	46	30	753	7.3	47	29	759	11.3	56
3,000	29	711	4.4	45	30	707	2.2	40	29	707	2.6	68	30	713	6.2	53	25	713	4.6	42	30	708	4.9	42	29	715	8.2	58
4,000	29	628	−1.0	42	30	624	−2.7	34	29	624	−3.5	61	30	630	0.8	48	25	631	0.3	29	29	626	−0.3	36	29	633	2.3	63
5,000	29	554	−7.3	42	29	549	−8.3	33	29	550	−8.9	54	30	556	−4.9	44	24	556	−5.5	28	29	552	−6.2	33	27	559	−3.7	56
6,000	29	486	−13.9	36	29	482	−14.6	36	29	482	−15.4	47	30	489	−11.5	41					29	485	−12.9	34	26	492	−9.1	47
7,000	29	425	−21.3	36	29	422	−21.6	35	29	422	−22.6	44	30	429	−18.2	39					29	424	−20.3	34	26	432	−16.2	41
8,000	29	371	−29.1	37	29	367	−29.0	36	29	367	−31.0	42	28	374	−25.9	37					29	370	−28.3	33	26	377	−24.0	40
9,000	29	322	−36.8	39	29	318	−36.1	34	29	318	−39.1	41	28	325	−34.0	36					28	321	−36.6	33	26	328	−32.0	39
10,000	28	278	−44.1		28	276	−43.1		28	274	−46.2		28	281	−41.8						28	277	−44.5		26	284	−39.8	38
11,000	28	239	−50.5		27	237	−49.4		28	236	−51.3		28	242	−48.9						28	239	−50.4		25	245	−47.3	
12,000	28	204	−55.3		27	204	−54.2		27	202	−53.6		28	208	−54.8						28	204	−53.6		24	210	−54.2	
13,000	26	175	−57.6		27	174	−57.4		27	173	−54.7		28	178	−58.9						28	174	−55.6		24	180	−60.1	
14,000	25	149	−59.8		26	148	−59.4		26	148	−56.1		26	151	−62.4						28	149	−57.6		24	153	−64.6	
15,000	25	127	−61.4		25	126	−60.3		24	126	−57.9		25	128	−64.8						26	127	−59.6		24	130	−68.5	
16,000	25	108	−62.1		22	108	−60.4		23	108	−59.1		24	109	−65.8						25	108	−60.9		24	110	−70.4	
17,000	25	92	−61.5		19	92	−59.6		22	92	−59.5		23	93	−65.2						23	92	−61.2		22	93	−69.5	
18,000	23	78	−60.1		14	78	−58.6		21	78	−59.2		22	79	−63.4						22	78	−60.4		22	78	−66.7	
19,000	20	67	−58.5		8	66	−57.5		18	66	−58.9		17	67	−61.3						16	67	−59.4		20	66	−63.8	
20,000	11	57	−57.2						15	56	−58.4		11	57	−58.9						9	57	−58.2		18	56	−61.1	
21,000	7	48	−56.2						5	48	−58.0		8	48	−57.5						5	48	−57.5		13	48	−58.9	
22,000													5	41	−56.1										8	41	−56.7	
23,000																									7	35	−55.5	
24,000																									7	29	−54.4	

See footnotes at end of table.

TABLE 1.—*Mean free-air barometric pressure in millibars, temperature in degrees Centigrade, and relative humidities in percent, obtained by airplanes and radiosondes during September 1940*—Continued

Altitude (meters) m. s. l.	Stations and elevations in meters above sea level																			
	Omaha, Nebr. (301 m.)				Pearl Harbor, T. H.[1] [2] (6 m.)				Pensacola, Fla.[1] [3] (24 m.)				Phoenix, Ariz. (339 m.)				San Diego, Calif.[1] [3] (19 m.)				Sault Ste. Marie, Mich. (221 m.)			
	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity
Surface	30	983	18.1	72	30	1,014	23.3	85	28	1,015	21.2	82	30	971	26.7	55	30	1,011	18.3	87	29	991	11.2	94
500	30	961	19.2	64	30	959	22.0	81	28	960	21.8	69	30	954	29.3	44	30	955	17.7	74	29	959	11.7	89
1,000	30	906	17.7	57	30	905	19.2	80	28	906	18.4	69	30	901	27.3	40	30	901	18.4	48	29	903	10.3	85
1,500	30	855	15.3	53	30	854	16.6	74	28	855	15.3	67	30	852	23.5	43	29	850	18.0	39	29	851	7.9	80
2,000	30	805	12.7	53	30	805	14.3	66	28	806	13.0	59	30	803	19.6	49	29	801	15.7	38	29	800	5.3	74
2,500	30	758	10.0	51	30	759	12.7	48	28	758	10.5	53	30	758	15.6	55	29	755	13.1	38	29	752	2.8	72
3,000	29	714	7.2	47	30	715	11.0	36	28	714	7.5	49	30	714	11.7	62	23	711	9.9	37	29	707	0.4	66
4,000	29	632	0.9	47	30	633	6.3	24	27	632	1.0	43	29	633	4.4	67	13	630	3.3	39	28	623	−5.9	62
5,000	29	557	−4.7	42					9	558	−4.9	46	29	560	−1.5	62	11	556	−3.0	38	26	548	−12.1	56
6,000	29	490	−10.9	36					9	492	−11.3	45	29	493	−7.4	55	11	489	−9.7	26	26	480	−18.0	30
7,000	29	430	−17.8	34					9	431	−18.0	45	29	433	−13.9	48	11	429	−17.2		26	419	−25.7	48
8,000	29	375	−25.3	33					8	376	−25.3	45	29	379	−21.3	45	10	373	−25.3		26	364	−33.1	48
9,000	29	326	−33.4	33					8	327	−31.9		29	330	−29.2	42	9	324	−32.4		26	315	−40.7	46
10,000	29	282	−41.2						7	284	−39.2		29	287	−36.9	41	8	281	−39.2		26	272	−47.3	
11,000	28	243	−48.6						7	245	−47.6		29	247	−43.9		8	242	−44.3		25	233	−51.7	
12,000	28	208	−55.0						7	210	−55.5		29	213	−50.2		8	209	−49.5		23	200	−54.6	
13,000	26	178	−58.7						6	179	−63.6		29	182	−55.9		7	179	−55.7		22	171	−55.9	
14,000	24	151	−61.4						5	151	−71.7		29	155	−61.2		7	154	−60.4		22	146	−57.1	
15,000	24	129	−63.8										29	132	−65.5		7	130	−64.2		22	125	−57.9	
16,000	23	110	−64.2										28	112	−68.1		5	111	−66.8		17	106	−58.5	
17,000	22	93	−63.1										28	95	−68.1						14	91	−58.3	
18,000	20	79	−61.5										25	80	−66.3						10	78	−57.9	
19,000	16	67	−59.8										22	68	−63.6						6	66	−56.8	
20,000	10	57	−57.6										19	58	−60.4									
21,000													12	49	−58.1									
22,000													7	41	−56.8									

Altitude (meters) m. s. l.	Stations and elevations in meters above sea level																			
	Seattle, Wash.[1] (27 m.)				St. Thomas, V. I.[1] [2] (8 m.)				Washington, D. C.[1] (7 m.)				Atlantic Station No. 1[2] (3 m.)				Atlantic Station No. 2[4] (3 m.)				Atlantic Station No. 1[2] (late report for August 1940) (3 m.)			
	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity
Surface	21	1,011	15.7	83	29	1,014	27.4	83	20	1,018	15.2	82	23	1,016	22.3	72	27	1,019	22.3	82	26	1,020	23.1	72
500	21	956	15.2	67	29	958	21.6	97	20	960	14.8	70	23	959	17.9	78	27	962	18.6	85	26	962	19.3	78
1,000	21	902	12.8	64	29	904	18.5	90	20	905	12.3	68	23	905	14.4	81	27	907	15.3	85	26	908	15.6	80
1,500	21	850	10.4	66	29	853	16.0	80	20	852	9.3	67	23	853	11.9	77	27	855	12.8	82	26	856	12.8	75
2,000	21	800	7.8	61	29	804	13.5	73	20	802	7.2	56	23	803	10.3	68	27	806	10.8	74	25	806	10.9	62
2,500	21	752	4.5	63	29	757	11.2	69	20	754	5.9	43	23	756	8.2	62	27	758	8.5	68	25	759	9.3	52
3,000	21	707	1.4	65	29	713	8.7	61	20	709	3.9	36	23	712	6.0	56	27	714	6.1	62	25	714	7.0	49
4,000	21	624	−4.1	50	29	632	2.9	52	20	626	−1.8	44	23	629	1.0	49	27	631	0.9	49	22	632	1.6	47
5,000	21	549	−10.0	44					19	551	−7.3	46	23	555	−4.9	45	27	557	−4.8	42	22	558	−3.9	43
6,000	21	481	−16.6	36					19	484	−13.6	51	23	488	−10.8	43	27	490	−11.2	40	20	490	−10.0	39
7,000	20	421	−24.3	36					19	424	−19.9	49	23	428	−18.0	40	27	429	−18.2	39	19	430	−16.5	37
8,000	20	366	−31.9	43					13	371	−27.1		21	373	−25.8	40	26	375	−25.6	39	19	375	−23.9	36
9,000	16	317	−39.8						12	321	−34.7		19	324	−33.4	41	26	325	−33.2	39	17	326	−31.6	36
10,000	16	273	−47.3						11	278	−42.1		19	281	−41.3		26	282	−41.1		16	283	−39.8	38
11,000	12	234	−51.3						9	239	−48.6		17	241	−49.0		25	243	−48.8		15	244	−47.0	
12,000	10	202	−52.4						7	204	−54.5		16	207	−54.8		25	208	−55.4		13	209	−53.2	
13,000	9	173	−53.1						6	175	−57.5		16	177	−58.2		25	178	−59.7		11	178	−57.0	
14,000	8	149	−54.0										16	150	−61.6		22	151	−61.4		9	152	−59.6	
15,000	7	127	−55.1										15	128	−63.6		20	129	−62.0		7	129	−61.0	
16,000	6	108	−55.5										13	109	−63.2		18	110	−61.9					
17,000	5	92	−55.7										13	93	−62.3		16	93	−61.3					
18,000													12	79	−60.7		12	79	−60.1					
19,000													12	67	−59.2		9	68	−58.9					
20,000													8	57	−57.8		7	58	−57.7					
21,000																	5	50	−56.7					

[1] U. S. Navy.
[2] Airplane observations.
[3] In or near the 5° square. Lat. 35°00′ N. to 40°00′ N.; long. 55°00′ W. to 60°00′ W.
[4] In or near the 5° square. Lat. 40°00′ N. to 45°00′ W.; long. 40°00′ W. to 45°00′ W.
[5] Airplane and radiosonde observations.

NOTE.—All observations taken at 12:30 a. m., 75th meridian time, except at Washington, D. C., and Lakehurst, N. J., where they are taken near 5 a. m., E. S. T., at Norfolk, Va., where they are taken at about 6 a. m. and at Pearl Harbor, T. H., after sunrise.

None of the means included in this table are based on less than 15 surface or 5 standard level observations.

Number of observations refers to pressure only as temperature and humidity data are missing for some observations at certain levels; also, the humidity data are not used in daily observations when the temperature is below −40.0° C.

TABLE 2.—*Free-air resultant winds based on pilot-balloon observations made near 5 p. m. (75th meridian time) during September 1940. Directions given in degrees from North (N=360°, E=90°, S=180°, W=270°)—Velocities in meters per second*

Altitude (meters) m. s. l.	Abilene, Tex. (537 m.)			Albuquerque, N. Mex. (1,630 m.)			Atlanta, Ga. (299 m.)			Billings, Mont. (1,095 m.)			Bismarck, N. Dak. (512 m.)			Boise, Idaho (870 m.)			Brownsville, Tex. (7 m.)			Buffalo, N. Y. (220 m.)			Burlington, Vt. (132 m.)			Charleston, S. C. (18 m.)			Chicago, Ill. (192 m.)			Cincinnati, Ohio (157 m.)			Denver, Colo. (1,627 m.)		
	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity
Surface	30	121	3.3	30	216	1.5	30	26	2.2	29	79	2.2	30	130	2.1	28	29	0.3	30	62	5.2	29	263	3.0	30	254	0.7	29	87	1.5	30	353	0.8	30	330	0.5	29	13	1.4
500							30	22	2.5										30	57	5.5	29	266	4.1	30	264	1.6	29	63	2.4	30	337	.9	30	338	1.4			
1,000	30	125	4.1				30	42	1.9				30	136	1.6	28	74	.2	30	44	3.7	29	274	5.1	29	289	3.9	27	37	2.1	30	279	2.5	30	320	1.7			
1,500	30	139	3.5				30	34	1.9	29	92	2.5	30	160	2.1	28	154	1.3	28	21	3.5	29	280	5.7	27	300	5.3	26	6	2.3	30	282	3.9	30	306	2.1			
2,000	29	140	3.2	30	211	2.0	28	44	2.3	29	114	2.1	29	190	2.6	27	160	2.0	24	24	3.7	27	286	6.0	24	302	6.3	22	336	2.7	26	297	3.4	29	312	2.4	29	45	1.2
2,500	27	158	2.3	30	217	2.4	28	28	2.5	28	184	2.2	26	249	2.5	26	186	2.6	23	19	4.0	23	298	6.0	18	311	7.1	22	328	2.7	24	294	3.4	27	318	3.5	27	102	1.4
3,000	25	123	1.0	30	228	2.5	28	14	2.8	27	217	3.9	25	269	3.9	24	191	3.6	21	14	4.2	19	310	6.1	11	315	7.5	20	317	2.5	19	294	4.8	24	316	4.7	27	133	1.5
4,000	23	324	2.6	29	234	4.2	26	331	2.0	25	237	7.5	23	284	6.0	23	210	7.0	17	28	2.5	15	309	7.1				17	300	3.8	17	317	5.9	22	323	6.4	26	235	3.4
5,000	21	323	4.2	27	248	6.2	20	309	4.3	23	237	8.9	22	288	7.2	18	206	8.8	15	340	3.3	12	320	8.4				16	286	4.9	17	330	5.8	19	326	6.5	22	255	6.3
6,000	21	309	5.1	26	242	7.1	20	288	6.0	22	240	8.9	18	294	9.6	15	209	10.6	13	318	4.5	10	328	8.9				14	288	5.8	15	324	8.1	14	324	6.8	17	253	6.7
8,000	21	308	7.8	17	244	10.4	18	278	10.0	17	242	12.7	14	294	10.0	10	212	11.4	11	308	8.4							13	286	9.2	14	329	9.3	10	304	9.7	16	247	8.8
10,000	19	305	12.1	14	248	15.7	17	274	11.8	14	239	17.4	12	304	15.1													11	277	12.1	12	319	12.6				13	259	12.5
12,000	19	308	18.9	11	258	21.5	14	274	14.9																												12	261	17.4
14,000	18	323	11.6				13	269	14.9																														
16,000	12	304	13.2				12	266	8.1																														

Altitude (meters) m. s. l.	El Paso, Tex. (1,196 m.)			Ely, Nev. (1,910 m.)			Grand Junction, Colo. (1,413 m.)			Greensboro, N. C. (271 m.)			Havre, Mont. (766 m.)			Jacksonville, Fla. (14 m.)			Las Vegas, Nev. (570 m.)			Little Rock, Ark. (79 m.)			Medford, Oreg. (410 m.)			Miami, Fla. (10 m.)			Minneapolis, Minn. (261 m.)			Mobile, Ala. (10 m.)			Nashville, Tenn. (194 m.)		
	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity
Surface	30	154	2.2	30	193	4.9	29	320	1.3	30	23	1.7	29	141	0.4	27	65	3.4	30	173	2.3	30	71	1.2	30	316	1.3	30	47	2.2	30	186	1.0	30	85	1.5	29	6	1.5
500										30	30	2.0				26	61	4.7				30	43	2.3	30	315	1.7	30	50	3.0	30	184	2.1	30	64	2.6	29	11	2.0
1,000										29	15	2.4	29	196	.8	24	62	3.7	30	165	3.3	30	33	2.2	30	285	1.1	30	65	1.7	30	229	2.2	28	62	3.0	29	8	2.4
1,500	30	157	1.9							29	355	2.5	29	211	1.3	21	59	2.5	30	175	3.8	30	25	2.1	30	166	1.9	29	79	1.5	29	247	3.9	25	52	4.6	29	358	2.1
2,000	30	159	2.3	30	194	5.0	29	296	2.2	29	336	3.7	29	204	2.0	21	48	1.6	30	196	5.6	30	28	2.9	27	174	3.1	27	85	.8	27	268	4.8	24	54	4.6	29	340	2.7
2,500	30	173	1.7	30	189	5.5	29	235	2.7	27	326	4.6	29	221	2.7	20	73	1.3	30	198	6.9	28	22	2.2	26	174	5.1	27	193	.4	26	275	5.9	22	60	5.0	28	329	3.4
3,000	30	180	2.2	30	192	5.7	29	217	4.4	27	316	5.3	25	241	4.6	21	343	3.9	29	205	8.4	24	359	2.5	25	174	6.2	26	188	1.1	24	294	6.5	18	37	4.2	25	335	3.3
4,000	28	235	2.7	28	209	8.0	28	210	5.8	26	306	6.4	22	237	6.1	16	286	1.0	27	215	11.0	22	359	2.3	21	182	7.8	22	183	1.3	15	307	7.4	17	31	2.0	20	332	3.1
5,000	22	248	3.6	23	215	11.4	24	207	5.9	23	308	6.6	17	233	8.1	15	283	2.4	24	220	12.7	19	330	2.9	15	175	6.6	18	196	1.6	12	318	6.3	16	351	2.1	16	312	4.3
6,000	15	244	4.6	19	219	14.6	16	224	7.7	22	293	9.5	14	238	8.4	12	293	3.7	24	228	13.3	19	329	5.4	12	169	7.0	16	218	2.1							15	317	6.4
8,000				12	220	13.3				21	288	12.4	11	226	9.3				19	230	18.5	10	328	9.4	10	189	5.0												
10,000										21	281	15.1							16	239	24.7																		
12,000										15	268	17.6							13	243	28.9																		
14,000										11	270	15.2																											

Altitude (meters) m. s. l.	New York, N. Y. (15 m.)			Oakland, Calif. (8 m.)			Oklahoma City, Okla. (402 m.)			Omaha, Nebr. (306 m.)			Phoenix, Ariz. (344 m.)			Rapid City S. Dak. (982 m.)			St. Louis, Mo. (181 m.)			San Antonio, Tex. (183 m.)			San Diego, Calif. (15 m.)			Sault Ste. Marie, Mich. (230 m.)			Seattle, Wash. (14 m.)			Spokane, Wash. (603 m.)			Washington, D. C. (10 m.)		
	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity
Surface	30	311	1.1	30	273	5.0	29	159	3.3	30	166	3.1	30	182	0.7	29	116	1.8	30	1	0.9	30	81	2.5	29	289	4.2	27	284	1.9	29	279	2.2	25	177	0.7	30	315	1.1
500	30	305	2.3	30	277	4.9	29	159	3.6	30	170	4.0	30	185	1.0				30	19	1.2	30	75	3.6	29	291	3.0	27	288	3.3	29	283	.5				30	317	2.4
1,000	29	299	4.2	29	266	2.2	29	167	3.5	29	184	3.7	30	184	1.9	29	116	1.7	30	332	.4	30	66	3.5	28	218	1.9	24	288	5.9	27	206	.6	25	154	.9	30	318	3.2
1,500	28	299	5.6	28	195	2.5	28	174	3.4	28	212	4.0	30	179	2.7	29	122	1.7	30	272	1.0	29	66	3.6	28	198	3.4	21	297	7.8	22	166	2.6	25	143	1.6	29	308	5.1
2,000	24	315	6.3	28	184	3.8	28	185	3.1	28	241	3.8	30	188	3.8	29	159	1.8	30	296	2.7	28	58	3.2	28	191	5.1	18	304	6.9	19	174	4.3	24	174	2.2	28	310	5.8
2,500	22	306	6.2	28	179	4.9	27	228	2.4	28	271	3.2	30	203	4.6	28	215	2.1	29	301	3.3	26	51	3.0	26	188	5.8	16	313	7.1	16	146	3.4	22	183	3.8	26	309	7.2
3,000	20	300	6.9	28	181	5.2	26	240	2.3	28	286	3.9	29	206	5.5	25	230	3.6	27	308	3.8	25	39	3.2	25	202	6.9	14	305	9.1	15	140	3.3	21	188	3.3	23	310	7.9
4,000	16	299	7.6	26	214	5.5	23	299	4.1	23	303	4.9	25	220	7.5	21	261	6.0	26	324	5.0	25	14	4.0	22	206	9.0				14	146	5.3	19	197	5.3	18	295	8.5
5,000	12	299	9.4	25	227	7.6	19	324	5.0	22	303	7.0	25	222	6.4	21	263	7.5	22	333	6.3	23	348	3.3	20	214	10.0				13	166	3.3	14	203	8.2	15	280	10.3
6,000				23	237	8.9	19	321	6.2	21	305	8.6	24	226	8.6	20	260	8.5	21	322	7.3	20	320	5.3	10	226	10.4				13	188	5.0	12	212	8.5	13	290	11.9
8,000				18	229	11.1	17	316	9.3	21	306	12.1	19	231	12.2	17	263	12.1	19	324	12.0	15	299	8.1							12	213	6.4	12	215	10.7			
10,000				13	268	10.6	11	320	14.8	18	311	16.2	18	241	18.5	13	261	15.2	13	339	15.6	13	296	10.8										11	221	16.9			
12,000				10	244	15.8				14	297	17.4	15	237	23.8	10	261	18.4	10	334	15.7	10	300	15.8															
14,000				10	253	18.0				12	294	17.0	12	240	20.8	10	254	16.2																					

TABLE 3.—*Maximum free-air wind velocities (m. p. s.), for different sections of the United States, based on pilot-balloon observations during September 1940*

Section	Surface to 2,500 meters (m. s. l.)					Between 2,500 and 5,000 meters (m. s. l.)					Above 5,000 meters (m. s. l.)				
	Maximum velocity	Direction	Altitude (m.) m. s. l.	Date	Station	Maximum velocity	Direction	Altitude (m.) m. s. l.	Date	Station	Maximum velocity	Direction	Altitude (m.) m. s. l.	Date	Station
Northeast [1]	30.5	NW	2,500	21	Harrisburg, Pa.	43.0	WSW	4,880	10	Harrisburg, Pa.	46.5	NW	12,230	22	Columbus, Ohio.
East-Central [2]	29.0	WSW	1,580	25	Richmond, Va.	35.4	WNW	5,000	12	Nashville, Tenn.	49.2	NW	12,640	13	Louisville, Ky.
Southeast [3]	23.8	S	2,150	24	Montgomery, Ala.	27.1	WNW	5,000	11	Birmingham, Ala.	59.0	W	13,790	13	Charleston, S. C.
North-Central [4]	31.7	NNW	570	9	Duluth, Minn.	39.8	W	4,900	24	Sault St. Marie, Mich.	56.0	N	9,800	10	Bismarck, N. Dak.
Central [5]	30.4	SW	910	18	Des Moines, Iowa.	37.2	N	3,640	24	North Platte, Nebr.	70.4	WSW	18,810	27	Springfield, Ill.
South-Central [6]	32.5	SSE	1,900	29	Amarillo, Tex.	33.7	S	2,810	30	Amarillo, Tex.	78.0	WNW	21,230	12	San Antonio, Tex.
Northwest [7]	27.3	WSW	1,340	3	Great Falls, Mont.	30.8	S	4,490	4	Butte, Mont.	53.2	WSW	5,950	6	Missoula, Mont.
West-Central [8]	23.3	SSE	2,380	2	Sheridan, Wyo.	34.4	SW	5,000	4	Rock Springs, Wyo.	49.5	SW	10,100	4	Ely, Nev.
Southwest [9]	28.1	SW	2,500	27	Las Vegas, Nev.	41.1	SW	3,180	27	Las Vegas, Nev.	68.8	WSW	11,432	15	Las Vegas, Nev.

[1] Maine, Vermont, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, and northern Ohio.
[2] Delaware, Maryland, Virginia, West Virginia, southern Ohio, Kentucky, eastern Tennessee, and North Carolina.
[3] South Carolina, Georgia, Florida, and Alabama.
[4] Michigan, Wisconsin, Minnesota, North Dakota, and South Dakota.
[5] Indiana, Illinois, Iowa, Nebraska, Kansas, and Missouri.
[6] Mississippi, Arkansas, Louisiana, Oklahoma, Texas (except extreme west Texas), and western Tennessee.
[7] Montana, Idaho, Washington, and Oregon.
[8] Wyoming, Colorado, Utah, northern Nevada, and northern California.
[9] Southern California, southern Nevada, Arizona, New Mexico, and extreme west Texas.

TABLE 4.—*Mean altitudes and temperatures of significant points identifiable as tropopauses during September 1940, classified according to the potential temperatures (10° intervals between 290° and 409 °A.) with which they are identified (based on radiosonde observations)*

Stations	Bismarck, N. Dak.			Brownsville, Tex.			Charleston, S. C.			Denver, Colo.			El Paso, Tex.			Ely, Nev.			Great Falls, Mont.		
Potential temperatures, °A.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.
290–299																					
300–309																					
310–319	1	8.1	−38.0													2	8.8	−44.5	1	9.2	−46.0
320–329	7	9.6	−44.6				2	8.8	−33.5	2	9.2	−38.0				17	9.3	−41.2	14	9.9	−48.6
330–339	29	10.9	−49.6	7	9.8	−36.7	10	10.6	−45.5	21	10.8	−48.3	8	10.1	−39.4	35	10.8	−48.2	27	11.0	−51.6
340–349	20	12.2	−56.3	14	11.4	−46.4	21	12.2	−54.6	25	11.8	−52.8	18	11.5	−47.6	15	12.1	−55.8	8	12.4	−58.2
350–359	10	13.3	−61.0	21	13.6	−61.1	18	13.4	−61.7	7	13.3	−60.3	20	13.4	−60.2	10	13.0	−58.4	6	12.9	−57.8
360–369	5	13.7	−59.6	16	14.8	−67.8	7	14.4	−64.4	10	14.9	−67.8	14	15.1	−70.3	10	13.7	−59.8	3	14.1	−62.7
370–379	2	14.0	−57.0	12	15.7	−71.2	9	15.4	−68.9	7	15.1	−66.3	14	15.8	−72.4	7	14.3	−60.0	6	14.4	−60.0
380–389	7	15.2	−62.4	12	16.4	−72.4	7	15.6	−66.1	4	15.8	−67.0	6	16.5	−73.7	11	15.2	−62.0			
390–399	6	15.7	−62.8	4	17.0	−71.5	5	16.5	−70.0	2	16.3	−68.0	8	16.9	−71.6	6	16.0	−63.8	4	15.6	−60.2
400–409	5	16.2	−61.4	3	17.5	−73.3	8	16.9	−68.2	7	16.7	−66.1	1	17.6	−73.0	6	16.4	−63.2	3	16.3	−62.3
Weighted means		12.5	−55.0		14.1	−61.8		13.7	−59.9		13.0	−56.9		14.0	−61.4		12.3	−53.4		12.0	−54.3
Mean potential temperature °A. (weighted)	351.3			363.7			361.0			354.7			361.8			351.8			345.6		
Number days with observations	27			26			26			26			28			28			28		

Stations	Joliet, Ill.			Lakehurst, N. J.			Medford, Oreg.			Nashville, Tenn.			Oakland, Calif.			Oklahoma City, Okla.			Omaha, Nebr.		
Potential temperatures, °A.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.
290–299																					
300–309							1	7.0	−38.0												
310–319	3	8.4	−41.3	1	8.0	−36.0	3	7.9	−40.0										1	9.2	−47.0
320–329	16	9.6	−45.4	8	9.1	−41.1	31	9.6	−45.4	8	9.0	−42.5	19	9.7	−44.7	4	10.1	−48.2	9	9.9	−46.0
330–339	22	11.1	−50.9	18	10.8	−50.8	26	10.9	−51.5	21	10.9	−50.2	30	11.0	−50.7	16	10.8	−48.0	25	10.9	−49.0
340–349	17	12.1	−57.0	9	12.2	−57.1	9	12.1	−56.3	14	12.1	−55.5	12	12.2	−56.7	18	12.2	−54.9	16	12.1	−55.6
350–359	5	13.1	−59.2	7	13.0	−58.7	4	12.8	−56.5	10	13.8	−64.4	2	12.8	−57.5	11	13.7	−63.2	6	13.4	−61.0
360–369	5	14.1	−62.8	4	14.0	−62.5	4	13.0	−53.7	8	14.2	−65.2	3	13.5	−56.7	8	15.1	−69.9	5	14.2	−63.2
370–379	5	14.6	−62.8	1	14.4	−60.0	5	14.1	−58.2	6	15.0	−65.5	5	14.4	−60.8	7	15.5	−70.4	11	15.0	−65.3
380–389	4	15.4	−64.5	1	14.8	−57.0	7	14.7	−58.0	8	15.4	−64.5	8	15.3	−62.2	11	16.2	−71.1	4	15.5	−65.0
390–399	5	15.5	−61.0	5	15.5	−62.8	3	15.9	−62.0	5	16.4	−66.2	6	15.7	−61.0				5	16.2	−66.6
400–409	5	16.2	−62.0	1	16.2	−62.0	6	15.1	−60.0	2	17.0	−67.5	2	16.1	−61.5	3	16.9	−68.7	2	16.8	−64.5
Weighted means		12.2	−54.4		11.9	−53.6		11.5	−51.5		12.8	−57.5		12.0	−53.2		13.4	−60.1		12.6	−55.9
Mean potential temperature °A. (weighted)	349.1			347.3			345.4			353.6			348.4			355.9			351.4		
Number days with observations	28			28			30			28			28			24			27		

TABLE 4.—*Mean altitudes and temperatures of significant points identifiable as tropopauses during September 1940, classified according to the potential temperatures (10° intervals between 290° and 409 °A.) with which they are identified (based on radiosonde observations)*—Continued

Stations	Phoenix, Ariz.			Sault Ste Marie, Mich.			Swan Island, W. I.			Atlantic Sta. No. 1[1]			Atlantic Sta. No. 2[2]		
Potential temperatures °A.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.
290–299				1	5.5	−31.0									
300–309				5	6.9	−37.8									
310–319				14	8.4	−44.6				1	8.8	−46.0			
320–329	1	8.7	−38.0	19	10.3	−52.5				5	9.7	−45.8	2	9.6	−44.5
330–339	16	9.9	−38.8	15	11.1	−53.7				14	11.3	−53.3	20	11.1	−51.0
340–349	27	11.4	−47.2	9	12.2	−57.8	20	11.8	−49.2	8	12.3	−57.9	19	12.5	−58.8
350–359	15	13.2	−58.7	2	12.4	−58.5	20	13.6	−61.6	4	13.7	−63.7	10	13.3	−60.8
360–369	15	14.5	−64.4	2	13.0	−56.5	18	15.5	−74.1	5	14.2	−64.6	4	14.3	−65.8
370–379	16	15.4	−67.4	3	14.6	−62.3	9	16.4	−77.4	5	14.8	−63.6	4	15.0	−66.0
380–389	12	16.2	−69.8	6	14.4	−57.3	5	17.2	−80.0	4	15.2	−64.0	1	14.8	−61.0
390–399	2	16.6	−69.5	1	15.1	−56.0				1	15.6	−62.0			
400–409	7	17.1	−69.4	5	16.0	−59.0	1	17.7	−77.0	1	16.2	−60.0			
Weighted means		13.4	−56.9		11.1	−52.2		14.2	−64.7		12.6	−57.5		12.4	−57.0
Mean potential temperature °A. (weighted)	360.0			338.9			359.6			350.4			345.9		
Number days with observations	29			24			24			18			23		

[1] In or near the 5° square: Lat. 35°00′ N. to 40°00′ N. Long. 55°00′ W. to 60°00′ W.
[2] In or near the 5° square: Lat. 40°00′ N. to 45°00′ N. Long. 40°00′ W. to 45°00′ W.

WEATHER ON THE NORTH ATLANTIC OCEAN

By H. C. HUNTER

Atmospheric pressure.—The pressure was lower than normal over most North Atlantic waters that are covered by reports at hand. There was a considerable deficiency from the vicinity of New England southward to the northern West Indies, the station at Turks Island having average pressure 2.5 millibars (0.074 inch) less than normal. On the other hand, pressure averaged somewhat greater than normal near northern Newfoundland. At Horta the pressure was nearly always above normal save for one week starting the 20th, when it was below, part of the week decidedly so.

The extremes of pressure found in vessel reports at hand were 1031.8 and 965.1 millibars (30.47 and 28.50 inches). The higher reading was noted on the American liner *Exeter*, late on the 13th, a short distance south of the central Azores. Table 1 indicates slightly higher readings at the land station at Horta within a few hours of that time.

The low mark was recorded on the American steamship *Franklin K. Lane*, near 38° N., 70½° W., at 9 p. m. of the 1st, when it met one of the intense storms from the Tropics. Readings quite low for that part of the ocean were noted in or near the Azores area, on both ship and shore, during the 23d to 25th, as detailed below. In high latitudes a reading of 995.6 millibars (29.40 inches) was recorded near Cape Farewell, on the 1st.

TABLE 1.—*Averages, departures, and extremes of atmospheric pressure (sea level) at selected stations for the North Atlantic Ocean and its shores, September 1940*

Station	Average pressure	Departure from normal	Highest	Date	Lowest	Date
	Millibars	*Millibars*	*Millibars*		*Millibars*	
Lisbon, Portugal[1]			1,023	10	1,008	30
Horta, Azores	1,020.9	−0.8	1,032	13, 14	994	25
Belle Isle, Newfoundland[2]	1,014.5	+2.3	1,028	15	999	26
Halifax, Nova Scotia	1,016.3	−1.3	1,028	29, 30	986	16
Nantucket	1,016.3	−2.3	1,028	30	993	2
Hatteras	1,016.3	−1.7	1,026	18	1,003	11
Turks Island	1,012.7	−2.5	1,016	24, 25	1,005	13
Key West	1,012.2	−1.7	1,017	18	1,007	9
New Orleans	1,015.6	+0.4	1,022	29	1,007	24

[1] For 16 days. [2] For 25 days.

NOTE.—All data based on available observations, departures compiled from best available normals related to time of observation, except Hatteras, Key West, Nantucket, and New Orleans, which are 24-hour corrected means.

Cyclones and gales.—The reports now available fail to indicate that any LOW which had come eastward over the North American continent was of much importance when over North Atlantic waters. During the first 3 weeks of the month the middle latitudes of the ocean were comparatively quiet, except as influenced by storms originating near or within the Tropics.

A LOW of unusual interest was noted early on the 22d, when the American steamship *Otho*, westbound, near 29½° N., 46½° W., met a south-southwest whole gale, the barometer dropping to 995.6 millibars (29.40 inches). The wind shifted from south to west-northwest. Late in the forenoon of the 23d this storm was encountered by the Portuguese steamship *Lobito*, about 700 miles to east-northeastward of the *Otho's* position, the wind blowing with full hurricane force from the southwest, while the barometer was 977.0 millibars (28.85 inches).

Later on the 23d this storm was felt in the westernmost Azores. The following extract is from a report kindly furnished to this office by the Meteorological Service of the Azores, Angra do Heroismo, Terceira Island:

> The storm * * * came over the Azores, passing south of Flores and Fayal—minimum pressure, at Horta 992 mb. (29.29 inches) at 4 h. the 24th—and turning northeast passed over San Miguel—minimum 984 mb. (29.06 inches) at 13 h. the 24th. (Hours herein are 30th meridian time.)
>
> It went then around, coming west-southwest to Terceira where the central calm was well felt near 7 h. 30 m. the 25th—minimum 984 mb.—passed again south of Fayal—second minimum 991 mb. (29.26 inches) at 19 h. 30 m.—and it disappeared westward on the 26th, after being felt a second time at Flores Island.
>
> Wind attained force 9 and sometimes 10 (Beaufort), stronger before the passing of the center. Maximum 105 kilometers (65 miles) per hour at 4 h. 45 m. on the 25th, from the north—a gust, not steady velocity.
>
> Rain was unusually heavy from the 22d to the 26th. At Angra do Heroismo 333 mm. (13.11 inches) of rain were collected, that is, one-third of the average total rain in a year.
>
> Many damages were caused to houses and crops, and some boats were taken by the heavy seas from the places where they had been pulled ashore. An uncommonly high swell was remarked

Gales and storms.—Gales were reported on 10 days, the 1st, 2d, 10th, 13th, 14th, 15th, 18th, 22d, 23d, and 25th. Storms were reported on the 1st, 13th, 14th, 15th, 22d, 23d, and 25th.

at Angra do Heroismo, running from the southwest on the morning of the 24th. * * * No lives lost.

By the latter part of the 27th this cyclone was within the southward extending trough of a large LOW area near southern Greenland, and it apparently thereafter drew away to the northeastward with lessening force.

During the final 4 days of September a cyclone of moderate intensity moved slowly northward off the coasts of Florida, Georgia, and the Carolinas. One whole gale was noted by a vessel within the area affected.

On page 245 in this REVIEW is an account of two disturbances which advanced from the region of the West Indies along fairly similar paths to eastward of the coast of the United States. The earlier was not far from Cape Hatteras when September started, and three reports of hurricane winds also a report of force 11 are mentioned in the accompanying table of ocean gales.

The later storm was followed from the 11th, to northeastward of Saint Martin, to the 17th, when it had reached Nova Scotia. One vessel reported force 12 and another force 11 as met while under the influence of this storm.

A less important disturbance, which crossed the western Gulf of Mexico about the 21st to 23d, is described in the same article.

Fog.—The available reports indicate but little fog this month, yet some details of occurrence are of interest. In the wake of the second September disturbance of tropical origin, fog was noted on the 16th within four adjacent 5° squares, between 20° and 30° N., 65° and 75° W. Similarly, soon after the earlier disturbance had passed, there was fog on the 2d and 3d at positions to eastward of the coast from the Carolinas to New Jersey.

Near New England and southwestern Nova Scotia fog occurred on a few days, but after the 10th no fog was reported as occurring there save on the 20th. In this area the square 40° to 45° N., 65° to 70° W., yielded reports on 5 days, leading all other North Atlantic areas as far as advices show. However, records of earlier years indicate that on the average fog is seen there on 11 September days.

To the eastward of the forty-fifth meridian no mention of fog has been found in the reports at hand for this month.

OCEAN GALES AND STORMS

Vessel	Voyage		Position at time of lowest barometer		Gale began September	Time of lowest barometer September	Gale ended September	Lowest barometer	Direction of wind when gale began	Direction and force of wind at time of lowest barometer	Direction of wind when gale ended	Direction and highest force of wind	Shifts of wind near time of lowest barometer
	From—	To—	Latitude	Longitude									
NORTH ATLANTIC OCEAN			° ′	° ′									
Abangarez, Am. S. S.	Charleston	Boston	33 54 N.	74 36 W.	[1]31	1a, 1	1	1,005.8	N	WNW, 9	W	WNW, 9	NNW-W.
Dungannon, Am. S. S.	Port Arthur	Providence	35 50 N.	73 45 W.	[1]31	8a, 1	1	994.9	NE	NNE, 10	WNW	NNW, 12	NE-NW.
Amapala, Hond. S. S.	New York	Kingston	35 47 N.	74 25 W.	1	10a, 1	1	1,003.4	NW	NW, 8	NW	NW, 8	NNE-NW.
Esso Baltimore, Am. S. S.	Boston	Corpus Christi	35 30 N.	71 20 W.	1	12m, 1	1	1,004.7	SE	S, 9	SSW	S, 9	SE-SSW.
Amazone, Du. S. S.	New York	Port au Prince	36 12 N.	71 18 W.	1	3p, 1	1	995.0	SE	SSW, 11	SW	S, 11	SE-SW.
Susan V. Luckenbach, Am. S. S.	New York	Christobal	37 50 N.	72 50 W.	1	4p, 1	1	[2]1,000.0	E	N, 12	NNW	N, 12	NE-NNW.
Northland, U. S. C. G.	Torgilsby	Julianehaab	59 38 N.	44 35 W.	1	8p, 1	1	995.6	NE	NNE, 7	NW	NE, 8	NE-NW.
Franklin K. Lane, Am. S. S.	New York	Corpus Christi	[3]38 16 N.	70 32 W.	1	9p, 1	2	965.1	E	W, 8	WSW	WNW, 12	ESE-SW-WNW.
West Kebar, Am. S. S.	Freetown	Boston	30 42 N.	50 12 W.	4	4a, 5	5	1,016.6	SW	WSW, 4	WSW	SW, 8	SW-W.
Northland, U. S. C. G.	Ivigtut	Godhavn	68 30 N.	55 00 W.	6	3p, 7	8	1,006.4	S	S, 10	NW	SSE, 11	SSE-SSW.
J. A. Moffett, Jr., Am. S. S.	New York	Caripita	18 48 N.	63 36 W.	11	3p, 11	11	1,004.7	NW	WNW, 7	SW	W, 7	NW-W.
Meton, Am. S. S.	Curacao	Fall River	20 00 N.	68 30 W.	12	7p, 12	14	1,005.8	W	W, 7	SSW	SW, 8	
Borinquen, Am. S. S.	New York	San Juan	30 24 N.	71 00 W.	14	5p, 14	14	988.5	ENE	NNE, 12	W	NNE, 12	NE-N.
Coamo, Am. S. S.	San Juan	New York	30 14 N.	72 11 W.	14	11p, 14	15	989.5	SE	NW, 10	NNW	ENE, 11	ENE-NW.
President Roosevelt, Am. S. S.	New York	Bermuda	35 36 N.	70 54 W.	15	7p, 15	16	1,004.4	NNE	N, 9	NW	N, 9	N-NW.
Otho, Am. S. S.	Monrovia	New York	29 25 N.	46 30 W.	21	4a, 22	22	995.6	S	S, 9	W	SSW, 10	S-WSW.
Lobito, Port. S. S.	Lisbon	Philadelphia	36 38 N.	33 40 W.	23	11a, 23	24	977.0	S	SW, 12	NW	SW, 12	S-WNW.
Excambion, Am. S. S.	Bermuda	Lisbon	40 06 N.	31 42 W.	25	4a, 26	27	1,001.7	NNE	NE, 10	E	NNE, 10	NNE-E.
Astrea, Du. S. S.	Curacao	New York	32 18 N.	72 54 W.	26	7p, 26	27	1,013.5	NE	NE, 8	NE	NE, 8	SW-NE.
Malantic, Am. S. S.	Brunswick, Ga.	Philadelphia	35 03 N.	75 16 W.	27	2p, 30	[4]1	1,006.4	NE	NNE, 10	NE	NNE, 10	
President Van Buren, Am. S. S.	Trinidad	New York	36 30 N.	72 42 W.	30	11p, 30	[4]2	1,002.4	NE	NE, 9	NE	NE. 9	None.
NORTH PACIFIC OCEAN													
President Pierce, Am. S. S.	Hong Kong	Shanghai	26 00 N.	120 00 E.	[1]31	[1]5p. 31	1	984.1	W	W. 5	SE	SE, 10	W-N-SE.
Granville, Nor. M. S.	Los Angeles	Manila	18 07 N.	137 55 W.	4	2 p, 4	7	1,003.1	W	W, 5	WSW	WSW, 8	E-W.
Vacuum, Am. S. S.	Los Angeles	Vladivostok	43 50 N.	165 30 W.	5	11a, 5	6	992.2	S	S, 10	SW	SSE, 10	SSE-S.
San Luis Maru, Jap. M. S.	Los Angeles	Genzen	43 43 N.	173 55 W.	5	4p, 5	6	974.6	SW	SW, 8	WNW-WSW.	WSW, 9	WSW-SSW-WSW.
Crown City, Am. S. S.	Shanghai	Seattle	48 36 N.	176 24 E.	5	12p. 6	6	1,000.0	N	NNW, 6	N	N, 8	
Hie Maru, Jap. M. S.	Vancouver, B. C.	Yokahama	51 19 N.	168 30 W.	6	12m, 6	7	975.3	SE	SE, 8	SW	SE, 8	SSE-SE-SW.
Hoegh Silverstar, Nor. M. S.	San Francisco	Manila	20 42 N.	141 12 E.	5	7p, 6	7	987.6	NE	SW, 8	SW	SW, 9	None.
Steel Exporter, Am. S. S.	Belawan Deli	Honolulu	20 12 N.	131 26 E.	6	3a, 7	7	991.9	W	NNW, 8	W	WNW, 9	WNW-NE-WNW.
Aquarius, Am. S. S.	Bulan, P. I.	Los Angeles	19 30 N.	137 50 E.	7	9p, 7	8	980.0	SW	SW, 12	W	SW, 12	SSW-W.
Hoegh Silverstar, Nor. M. S.	San Francisco	Manila	19 24 N.	138 30 E.	7	11p, 7	8	974.3	SW	S, 10	SW	S, 11	SSW-S-WSW.
President Pierce, Am. S. S.	Yokohama	Honolulu	34 52 N.	142 00 E.	7	2a, 8	8	992.2	N	ENE, 8	S	ENE, 9	ENE-SE.
Explorer, U. S. C. & Geod. Survey.	On survey		52 42 B.	170 42 W.	11	4a, 12	12	999.7	SE	SSW, 7	SSW	SE, 9	SE-SW.
Collingsworth, Am. S. S.	Yokohama	Seattle	[3]40 10 N.	150 12 E.	12	6p, 12	13	999.7	SE	NE, 8	N	ENE, 10	ENE-NE.
Explorer, U. S. C. & Geod. Survey.	On survey		52 48 N.	169 54 W.	13	1a, 14	14	996.3	SE	S, 8		S, 8	
Discoverer, U. S. C. & Geod. Survey.	On survey		55 30 N.	161 36 W.	14	12m, 14	15	1,001.4		Var., 5	WSW	WSW, 11	Var.-WSW.
Tweedbank, Br. M. S.	San Francisco	Manila	19 00 N.	146 20 E.	14	12p, 15	16	1,009.1	SE	SE, 10	SSW	SE, 10	ESE-SE.
Collingsworth, Am. S. S.	Yokohama	Seattle	49 35 N.	174 45 W.	17	6p, 17	18	1,019.3	NW	NW, 8	NW	NW, 8	WNW-NW.
District of Columbia, Am. S. S.	San Francisco	Nagaeva	49 36 N.	158 00 W.	17	10p, 17	18	1,001.7	SW	W, 10	W	W, 10	SW-W.
Discoverer, U. S. C. & Geod. Survey.	On survey		54 54 N.	162 24 W.	17	2p, 17	18	979.7		SSW, 7	W	WNW, 8	SSW-W.
District of Columbia, Am. S. S.	San Francisco	Nagaeva	49 54 N.	167 30 W.	20	10p, 20	23	971.6	S	WSW, 12	NW	WSW, 12	SW-WNW.
Collingsworth, Am. S. S.	Yokohama	Seattle	49 48 N.	147 30 W.	20	4p, 21	22	995.6	SSW	SSE, 9	SE	SSE, 9	SSE-S.
Bering, Am. S. S.	Hilo	Balboa	14 30 N.	110 00 W.	21	2a, 22	22	1,000.7	WSW	WSW, 6	SW	SW, 7	W-SW.
Southern Cross, Pan. s. yacht.	Los Angeles	Balboa	18 00 N.	112 45 W.	22	5p, 23	24	983.4	NE	WSW, 12	SSE	WSW, 12	NW-S.
La Placentia, Am. S. S.	Port San Luis	Balboa	15 41 N.	95 32 W.	27	4p, 27	28	1,006.8	NNE	NNE, 6	NNE	N, 7	NNE-N.

[1] August. [2] Barometer uncorrected. [3] Position approximate. [4] October.

WEATHER ON THE NORTH PACIFIC OCEAN

By WILLIS E. HURD

Atmospheric pressure.—Over the greater part of the North Pacific Ocean during September 1940, the average pressure was not far from normal. At St. Paul Island, in the Bering Sea, however, the average barometer, 1,003.1 millibars (29.62 inches), was 3.0 millibars (0.09 inch) below the normal; but this region of the Aleutian LOW is subject to sharp and irregular fluctuations. The same is true, but to a less extent, of the opposite center of action—the North Pacific HIGH—which often crests near Midway Island. At Midway this month the average pressure, 1,018.8 millibars (30.08 inches), was 2.5 millibars (0.07 inch) above the month's normal.

The most noticeable instance of abnormal pressure this month occurred over the Ogasawara (Bonin) Islands. The average at Titijima was 1,007.5 millibars (29.75 inches), which is 3.7 millibars (0.11 inch) below the normal. To the westward, Naha, in the Nansei Islands, had exactly normal pressure; to the southward, Guam had pressure 2.0 millibars (0.06 inch) below the normal. The considerable minus departure over the Ogasawaras and southward was due to several days of typhoon activity in the vicinity.

TABLE 1.—*Averages, departures, and extremes of atmospheric pressure at sea level, North Pacific Ocean, September 1940, at selected stations*

Stations	Average pressure	Departure from normal	Highest	Date	Lowest	Date
	Millibars	*Millibars*	*Millibars*		*Millibars*	
Point Barrow	1,006.6	−5.9	1,019	10	995	18, 19
Dutch Harbor	1,004.8	−3.0	1,023	16	968	21
St. Paul	1,003.1	−3.0	1,020	27	979	7
Kodiak	1,004.4	−1.7	1,025	9	978	18
Juneau	1,013.2	0.0	1,028	30	995	15
Tatoosh Island	1,015.2	−0.7	1,024	19	1,006	17
San Francisco	1,013.9	0.0	1,020	27	1,009	17
Mazatlan	1,009.8	0.0	1,016	1	1,006	20
Honolulu	1,014.2	−1.7	1,017	1	1,010	17
Midway Island	1,018.8	+2.5	1,024	1, 2	1,010	28
Guam	1,008.2	−2.0	1,015	20	1,001	29
Manila	1,007.6	−0.5	1,012	21, 22	1,002	28, 29
Hong Kong	1,008.1	0.0	1,013	20	1,002	30
Naha	1,007.8	0.0	1,015	18, 19, 21	999	6, 7
Titijima	1,007.5	−3.7	1,017	21	964	6
Petropavlovsk	1,008.3	−1.9	1,027	21	992	28

NOTE.—Data based on 1 daily observation only, except those for Juneau, Tatoosh Island, San Francisco, and Honolulu, which are based on 2 observations. Departures are computed from best available normals related to time of observations.

Extratropical cyclones.—Following a period of weak depressions and almost complete lack of gale winds in upper latitudes of the Pacific during July and August 1940, cyclones began to develop more intensity in September. Pressure over and to the southward of the Aleutians fell below 982 millibars (29 inches) on several days, and gales at times took on an almost wintry severity. Practically all, however, so far as reports indicate, occurred between the longitudes of 175° E. and 155° W. The only exception thus far charted was a gale of force 8 which, beginning from a southwesterly direction on the 20th, reached its highest intensity, force 9 from the south-southeast, near 50° N., 148° W., on the 21st.

On the 5th a cyclone of some energy appeared central near 45° N., 175° W. Strong winds were rather widespread on that day. The highest was a southerly gale of force 10, experienced by the American steamer *Vacuum* near 44° N., 165° W. The lowest barometer, 974.6 millibars (28.78 inches), was read on the Japanese motorship *San Luis Maru*, in the midst of a westerly gale of force 9, near 44° N., 174° W. The cyclone moved northward with continued low barometer, accompanied by fresh gales, during the 6th, and on the 7th had passed into Bering Sea.

During the 11th to 14th a stormy period was reported over the central Aleutians and lower Peninsula of Alaska by the Coast and Geodetic Survey steamships *Explorer* and *Discoverer*. Gales of force 9 were encountered among the islands on the 11th and 12th, but the heaviest gale, west-southwest, force 11, was felt by the *Discoverer* while cruising along the peninsula, in 55° 30′ N., 161° 36′ W.

A further stormy period occurred in Aleutian waters from the 17th to 22d, during which gale winds extended much farther eastward on the 21st, as previously noted. During this period occurred the most violent wind and the lowest barometer reported by a vessel for the month in northern waters, when, on the 20th, the American steamer *District of Columbia* encountered a west-southwesterly gale of force 12, barometer 971.6 millibars (28.69 inches), near 50° N., 168° W. On the same date an unnamed vessel reported a westerly gale of force 10, near 51° N., 177° W. On the 17th the *District of Columbia* faced a similar whole gale while near 50° N., 158° W. The lowest barometer recorded in northern waters during the month, 968 millibars (28.58 inches), occurred at Dutch Harbor on the 21st.

During the second decade of September several depressions occurred, central off the west coast of the United States, but do not appear to have been attended by winds of gale force.

Tropical cyclones.—Subjoined is a report by the Rev. Bernard F. Doucette, S. J., of the Weather Bureau, Manila, P. I., on five known typhoons, in addition to a possible further tropical storm near 18° N., 159° E., that occurred in Far East waters during the month. The winds in at least two of these typhoons, those of September 2–12 and of September 22 to October 2, reached hurricane intensity. The highest known velocity attained in the typhoon of the 11th to 15th was of force 10 from the southeast, reported by the British motorship *Tweedbank* near 19° N., 146° E., on the 15th.

Added comment may be made concerning the typhoon of the 2d to 12th which, then of high intensity, passed over the Ogasawaras (Bonins) on the 6th, and was central to the northwestward of the islands on the 7th and 8th, apparently between 25° and 30° N., and not far from 140° E. Between the hours of 9 p. m. on the 7th and 1 a. m. on the 8th, two ships, the American *Aquarius* and the Norwegian *Hoegh Silverstar*, encountered southerly to southwesterly winds of forces 11 to 12, with lowest barometer—on the *Hoegh Silverstar*—down to 974.3 millibars (28.77 inches). At midnight of the 7th–8th, far to the northward, near 35° N., 142° E., the steamer *President Pierce*, was facing an east-northeast gale of force 9, barometer 992.2 millibars (29.30 inches). The typhoon on those dates thus had a gale field of enormous extent. The final gales of the storm, before its disappearance from observation on the 13th, were encountered on the 12th, near 40° N., 150° E., by the American steamer *Collingsworth*. This ship's highest wind was of force 10 from east-northeast, at 4 p. m.

In the American Tropics two cyclones occurred, of which one was a hurricane. The earlier was encountered in the trade-wind belt by the Norweigian motorship *Granville*, Los Angeles toward Manila. On the afternoon of the 4th, near 18° N., 138° W., the ship had lowest barometer, 1,003.1 millibars (29.62 inches), with mostly west winds of force 5–6. The highest wind reported was west-southwest, force 8, on the 5th. The wind shifts in the disturbance, which was traveling westward, were from east to west.

First indications of the hurricane came from the American steamer *Bering*, Hilo toward Balboa. At 2 a. m. of September 22 the vessel reported her lowest barometer, 1,000.7 millibars (29.55 inches), in 14°30′ N., 110° W., and from 4 a. m. till noon, the highest wind, southwest, force 7. At local noon of the 22d the Panamanian steam yacht *Southern Cross*, south-bound toward Balboa, had falling barometer near 20° N., 110° W. The winds rose in the afternoon and by midnight were from east-northeast, force 9. During the forenoon of the 23d the northeasterly winds became increasingly heavy, rising to force 11 at noon, and driving the vessel off her course. In the afternoon, the winds were mostly of hurricane force, changing from north-northwest to west-southwest. The yacht's lowest barometer was 983.4 millibars (29.04 inches) in 18° N., 112°45′ W., at 5 p. m. Southerly winds of force 11 continued until after 4 a. m. of the 24th and then rapidly moderated. The hurricane, then over the Revillagigedo Islands, was apparently headed in a direction which would, if continued, have taken it well to the seaward of Lower California, but no later reports of its movements are available.

In the Gulf of Tehuantepec a northerly wind of force 7 was observed on the 27th.

Fog.—Along the open northern waters of the Pacific fog was scattered, but was reported on 6 days east and 6

days west of the 180th meridian. In American coastal waters fog was noted on 10 days each off Washington and California; on 4 days off Oregon; and on 3 days off Lower California.

TYPHOONS AND DEPRESSIONS OVER THE FAR EAST

By BERNARD F. DOUCETTE, S. J.

[Weather Bureau, Manila, P. I.]

Typhoon, August 28–September 5, 1940.—A low-pressure area far to the southeast of Guam moved west-northwest, rapidly developing to typhoon intensity as it proceeded. When the center reached the regions about 250 miles west of Guam, the direction changed to the northwest, and the storm continued along this course until it reached the latitude of southern Formosa. It shifted its movement to the west for 1 day (September 4) and disappeared east or east-southeast of Ishigakijima after a short inclination to the northwest.

Typhoon, September 2–12, 1940.—A low-pressure area appeared far to the east-northeast of Guam, moved west-northwest and became a typhoon, September 2, located about 300 miles north-northeast of Guam. It continued moving west-northwest, gradually inclining to the north-northwest, and passed about 90 miles southwest of the Bonins during the early morning hours of September 7, after shifting to the west-northwest. A change to the north occurred which brought the storm center to the ocean regions between the Bonins and Japan, September 9. It seemed to be stationary during the day, due to a high-pressure area over northern Japan and the Pacific Ocean. September 10, however, showed the center moving west-southwest, and it is thought that instead of being stationary on the preceding day, the center may have made a loop before moving toward the west-southwest. Over the ocean regions south of Japan, the typhoon changed to the northwest, a course which brought it to Kiu-siu Island. September 11, the storm recurved to the northeast over this island and on the following day it had weakened, apparently to a low pressure area which moved northeast across Japan.

The afternoon observation, September 6, from the Bonins, was the lowest in the series reported from that island during this storm. Pressure was 723.0 mm. (963.9 mb.) with north-northeast winds of force 12. From latitude 29° N., longitude 134° E., on the morning of September 10, a ship, name unknown, reported west winds, force 11, with pressure at 729.0 mm. (971.9 mb.).

While this storm was in progress, an observation was received from a ship, name unknown, in latitude 17°54′ N., longitude 158°48′ E., with west winds of force 8 and pressure at 996.2 mb. (September 7). This indicated the existence of a typhoon far to the east-northeast of Guam, but no other evidence was received either from that ship or other ships, to show its origin and progress. It is possible that there may have been a communication error and that the position given was wrong, but there is no way to check this at present.

Typhoon, September 6–7, 1940.—This typhoon must be considered in connection with the typhoon of August 28 to September 5, for it is possible that it might be the same disturbance. Until further evidence is received, it will be treated as a separate typhoon, which was central about 600 miles east of southern Formosa, September 6, and which then curved northwest, north, and northeast for 1 day, after which it weakened to a depression and then disappeared. No trace of the storm could be found on September 8. The observations which made this storm appear to be independent of the typhoon of August 28–September 5, are the following: The S. S. *Steel Exporter* reported 0700 G. C. T. September 6, from latitude 20°18′ N., longitude 129°30′E., a pressure of 744.8 mm. (993.0 mb.) with west-northwest winds of force 9. Also, the morning observation, September 6, from Rasa Jima Island (one of the Nansei Island group) was 747.8 mm. (997.0 mb.) for pressure and east-northeast, force 4, for winds.

Typhoon, September 11–19, 1940.—A depression, moving westerly, passed about 200 miles south of Guam and quickly inclined to the north, intensifying to typhoon strength, September 11 to 13. It was stationary, September 13 and 14, about 150 miles west-northwest of Guam, and then began a northwesterly and northerly course to the ocean regions about 300 miles west of the Bonins, where it recurved to the north-northeast and moved very rapidly toward the northern Pacific Ocean. The morning observation received from Hatidyozima Island, September 18, was 737.3 mm. (983.0 mb.) with north-northeast winds, force 7, which shows better than any other available observation what intensity the storm had reached.

Typhoon, September 22–October 2, 1940.—This storm first appeared far to the south-southeast of Guam and seemed to be a fully developed typhoon, September 22. It moved along a course in general west-northwest, but varying to the northwest and west for short periods. It finally reached the eastern part of the Balintang Channel, September 29, and passed close to and north of Basco late in the afternoon of that day. It inclined to the northwest apparently, and moved close to and west of Formosa Island toward China. It is believed that the center did not cross any portion of Formosa but observations are needed to be certain. After crossing Formosa Channel the center entered the continent within 100 miles northeast of Amoy, inclining to the north. Over land, the storm weakened and recurved to the northeast and entered the Eastern Sea about 150 miles south of Shanghai as a mild depression which quickly disappeared.

The only part of the Philippine Archipelago affected by this typhoon was the Batan Islands. Basco, the location of the Weather Bureau station, reported a minimum pressure of 723.61 mm. (964.7 mb.) with northwest winds of force 12, September 29, at 6:45 p. m. No loss of life and no serious damage was reported.

Only during this typhoon was there any strength in the upper winds over the Philippines, and the velocities did not increase to values above 50 k. p. h. until September 28 and 29. First increasing at Cebu and Zamboanga from the southwest quadrant, then a day later at Manila, Dagupan, and Aparri, as the directions changed from the northwest and north quadrants to the southwest, it seemed that the southwest air stream was drawn toward the typhoon center. This activity did not extend south or southwest of Zamboanga, according to available data, for there was no increase in the velocities of the southwest monsoon over Bandon, Thailand, and Saigon, Indo-China. Compared with other typhoons, for example, those of July 2–9 and July 6–16, 1940, whose centers moved along courses similar to that of September 22–October 2, there was a very great difference in the activity of the southwest monsoon.

During the July typhoons Cebu and Manila had velocities up to and over 100 k. p. h. and stations over southern Indo-China and Thailand were almost always reporting velocities over 50 k. p. h., often reaching 80 and 90 k. p. h. This typhoon situation had characteristics much different than that during the last few days of

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September, when the southwest monsoon was not so active. In fact, it should be noted that the southwest monsoon current over the Philippine Islands, China Sea, and regions west and southwest, was quiet throughout the month of September, hardly ever reaching velocities of 50 k. p. h. and then only when a typhoon was exerting its influence. Bandon, Thailand, was reporting ascents almost every day until September 10, with velocities approximately 50 k. p. h., but the latter part of the month showed the southwesterly current much weaker. Regarding Guam, the velocities were almost always below 50 k. p. h., the exceptions being: (1) September 5 and 6, when the typhoon of September 2–12 was located north of Guam (southwest, west-southwest, west directions; 38–70 k. p. h. velocities); (2) September 15, when the typhoon of September 11–19 was central northwest of Guam (south to south-southwest directions; 44–67 k. p. h. velocities); and (3) September 24 and 25, when the typhoon of September 22–October 2 was west-northwest and northwest of Guam (southeast, south-southeast, and south directions; 29–67 k. p. h. velocities). U. S. Navy vessels at Tsingtao and Shanghai, China, frequently reported ascents that showed north, northeast, and east quadrant winds, with velocities between 20 and 60 k. p. h., sometimes due to typhoons, often not. This concludes the brief summary of September upper winds over the Far East.

RIVER STAGES AND FLOODS

By BENNETT SWENSON

Precipitation during September 1940 was deficient and river stages were generally low over the country east of the Rocky Mountains, except in New England and in portions of New Jersey, Oklahoma, and Kansas. In the area from the Rocky Mountains and Montana westward, except in California, the rainfall was decidedly above normal. Floods during the month were confined principally to small streams in New Jersey and the Arkansas River and tributaries in northeastern Oklahoma.

Atlantic Slope Drainage.—Heavy rains occurred on September 1 in southwestern New Jersey during the northward passage of a tropical disturbance with its center about 150 miles off the New Jersey coast. The greatest 24-hour amounts (within 12 hours at most stations) reported were: Clayton, 10.52; Pemberton, 6.70; Woodbury, 6.50; Woodstown, 5.40; North Merchantville, 5.19; Burlington, 4.86; Moorestown, 4.50, and Trenton No. 2, 4.91 inches. Severe flooding occurred in a number of the smaller rivers, and several dams broke, resulting in the loss of four lives and property damage (mostly to highways and bridges) estimated at more than $1,000,000.

Stages were slightly above flood stage at some points in the James, Santee, and Savannah Rivers early in September, being largely a continuation of the August flood conditions.

Arkansas Basin.—Unusually heavy rainfall occurred on September 3–4 over a small area in northeastern Oklahoma in the vicinity of the junction of the Cimarron and Arkansas Rivers. Rainfall amounts of 8 inches or more were recorded in a narrow band approximately 30 miles wide and 100 miles long, paralleling and lying just to the south and west of the Arkansas River from immediately south of Tulsa, Oklahoma, northwestward almost to the Kansas border. The area of greatest precipitation, 18 inches or more, was located in the triangle formed by the junction of the Cimarron and the Arkansas Rivers. The greatest single amount recorded in this area was 19.75 inches at Hallett, Okla.

The observed precipitation for the storm is given in table 1. These data were obtained through the cooperative hydrologic program conducted by the Weather Bureau in cooperation with the Departments of War and Agriculture.

Hourly rainfall amounts obtained from the Weather Bureau airport station recording-gage at Tulsa Airport are given in table 2. Additional precipitation reports by Weather Bureau observers in Oklahoma and in southeastern Kansas may be found in Climatological Data for September, issued by the section centers of the respective States.

The meteorological conditions which gave rise to the unusual precipitation are not clearly discernable on the surface weather map. However, the isentropic chart, from upper-air soundings, gives an explanation of the causes.

On the morning of September 3 a large, cold cyclonic eddy appeared on the 314° potential-temperature surface with center over Oregon. In advance of this eddy a moist tongue of air was advancing northward over extreme eastern Mexico, extending northward to extreme eastern Montana. The flow pattern gives some indication of a separate anticyclonic eddy branching eastward over Kansas.

On the same potential-temperature surface for the morning of September 4 the southern anticyclonic branch was well established, indicating a moist tongue curving sharply anticyclonically and moving up-slope toward the southeast over southeastern Kansas and northeastern Oklahoma. The stream functions showed this southern eddy to be centered over Texas. Another anticyclonic eddy composed mostly of dry air was central over southern Minnesota. Convergence between these two eddies and the upslope component in the moist eddy brought about the realization of the latent energy in the southern moist tongue. According to the flow pattern, Oklahoma City was not in the center of the moist tongue on either day, but, nevertheless, on both days the Oklahoma City upper-air soundings showed a lapse rate which indicated marked conditional instability. The Oklahoma soundings further indicated that the quantities of available precipitable water were quite high.

The flooding was severe along the Arkansas and Cimarron Rivers in the vicinity of Tulsa, Bristow, and Cleveland. The soil was dry and the stages in the streams were quite low at the beginning of the storm. These conditions tended to reduce runoff and alleviate flood conditions somewhat.

The Arkansas River at Tulsa rose from a stage of 1.8 feet at 8 a. m., to 16.0 feet at 7 p. m., of the 4th. The crest stage reached at that place was 19.3 feet on the morning of the 5th, 3.3 feet above flood stage and just 0.5 foot below the highest stage of record in June 1923. The losses in and around Tulsa have been estimated at more than a million dollars. At Fort Smith, Ark., the river rose to a stage of 19.8 feet on September 7, but no damage was reported.

TABLE 1.—*Observed precipitation and other notes, storm of September 3–4, 1940*

[DN denotes during night. DNA denotes during night after midnight]

Station	Date: September 1940	Began	Ended	Observed at	Amount, inches	Remarks
Creek County:						
Bowden (near)	3	DN		End of storm	16.25	Streeter-Speakman farm, located 1 mile south and 6¼ miles west of Bowden measured 16.25 inches in an oil barrel, straight sides. Oil barrel was empty at start of rain. Record reliable. U. S. E. D.
	4		p. m.			
Do	3	DN		do	13+	Harry Vandecar farm 1 mile south and 5¼ miles west of Bowden. 5-gallon can 13 inches high ran over. Exact time can ran over not known. U. S. E. D.
	4		p. m.			
Bristow	2			7:00 p	0	Weather Bureau observer. 8-inch standard nonrecorder. Heaviest rain fell from 10 a. m. to 3 p. m. on Wednesday. All highway traffic on US 66 eastbound held up in Bristow until Saturday.
	3	DNA	DNA	8:00 a	.49	
		11:20 a.	6:43 p.	7:00 p	.58	
	4	DNA	DNA	8:00 a	.55	
		8:52 a.	7:00 p.	7:00 p	4.29	
	5				0	
Bristow (near)	3	DN		After storm	9.50	Noel Dicks, central commercial lease, 9 miles north-northeast of Bristow, measured 9½ inches rainfall for the storm. Measurement made in a 11-inch-deep, straight-sided bucket. U. S. E. D.
	4		p. m.			
Do	3	DN		End of storm	6.90	E. R. Burrus, service station, had milk pail out in open which measured 0.725 foot deep, 10.8 inches across top, 8.4 inches across bottom. Amount of rainfall computed to be 6.9 inches. U. S. E. D.
	4		p. m.			
Drumright (near)	3			do	11.50	W. R. Whitehead, 1 mile west of Drumright substation or 6½ miles east of Drumright on Highway 67, measured 13½ inches in water keg which contained about 2½ inches in keg at start of rain; and straight-sided cooker, 9½ inches deep, ran over at 10 a. m. on Wednesday, probably not more than 2 or 3 inches fell after cooker overflowed. U. S. E. D.
	4					
Do	3	DN		do	3.00	Mr. Patton, located on farm 3 miles southwest of Drumright across from Oak Grove School, measured 3.0 inches in a well-exposed straight-sided can. Measurement good. Mr. Patton measures all rainfall but does not keep permanent record.
	4		P. m.			
Do	4	(1)			8.50	J. A. Gregory, located 9½ miles east of Drumright reported that 8.5 inches of rainfall was measured from 8 a. m. to noon on Wednesday. U. S. E. D.
Do	3			do	7.80	D. M. Ladd, located 6 miles east of Drumright and ½ mile south on Highway 67. 7.8 inches rainfall measured in tub. U. S. E. D.
	4					
Drumright	3			do	5.00	5.0 inches measured in water bucket at residence of Wayne Deeds in Drumright. U. S. E. D.
	4					
Drumright (near)	3			During storm	9.6+	J. B. Steele, 14 miles east of Drumright reported that No. 3 washtub ran over. Depth of rainfall equivalent for one No. 3 tub-full is 9.6 inches. U. S. E. D.
	4					
Do	3			1:00 p	9.6+	H. E. Glimp, 8 miles east of Drumright reported that No. 3 washtub ran over at 1 p. m. on Sept. 4, 1940. U. S. E. D.
	4					
Do	3	DN		(?)	8.7+	J. B. Johnson, 11 miles east of Drumright caught a No. 2 washtub full; tub ran over. Rainfall equivalent for No. 2 tub is 8.7 inches. U. S. E. D.
	4		P. m.			
Do	3	DN		(?)	5.2+	W. S. Summer, 10 miles east of Drumright had 10-quart pail 0.725 foot deep, 0.85 foot top diameter, 0.675 foot bottom diameter caught full. Rainfall equivalent of bucket full is 5.2 inches.
	4		P. m.			
Kellyville	3	Nite		End of storm	13.50	Tom Hawkins, Kellyville, Okla. Mr. Hawkins caught 13½ inches in a ½ of a 55-gallon oil drum. This is a reliable measurement. U. S. E. D.
	4		P. m.			
Kellyville (near)	3	DN		(?)	10+	Devonian Oil Co., located 2 miles southwest of Kellyville on U. S. Highway 66, report that gallon paint can 10 inches high with straight side ran over before rain stopped. Probably rained 3 inches more after can was full. Good exposure. Small creek just south of plant flooded, water reaching into pumping-plant equipment.
	4		Early p. m.			
Do	3			End of storm	12.00	Roy Ralston, 5 miles SW. of Kellyville measured 12 inches in a square tub. U. S. E. D.
	4					
Do	3			do	12.00	John H. Watkins farm, 0.8 mile west and 1 mile north of Kellyville. 12 inches measured in lard bucket during storm. This is a fair record. U. S. E. D.
	4					
Do	3			do	13.50	E. E. Greer, located 4 miles west of Kellyville on U. S. Highway 66, measured 13.5 inches of rainfall after storm. A good record. U. S. E. D.
	4					
Do	3			(?)	9.6+	Noah Sewell, 3½ miles east of Kellyville said that a No. 3 tub was filled and ran over; he estimated that an additional 5½ inches of rain fell after tub was filled. Rainfall equivalent for a full No. 3 tub is 9.6 inches. Estimated total for storm 15 inches. U. S. E. D.
	4					
Do	3			(?)	12.6+	B. F. Seifert, 5 miles southeast of Kellyville. Mr. Seifert stated that a bucket 12.6 inches deep ran over and that very little rain fell after bucket was filled. U. S. E. D.
	4					
Do	3			(?)	12.5+	Fred Cornelius, 4 miles south and 1 mile west of Kellyville measured a 12½-inch deep bucket. States that bucket ran over a little.
	4					
Keystone (near)	3			End of storm	13.80	Tom Starform, 3 miles south of Keystone on Coyote Trail measured 1.15 feet of rainfall in a 10-gallon straight-sided can. This measurement should be considered very good. U. S. E. D.
	4					
Mannford	3			do	16.00	George Moore, Mannford, Oklahoma, measured 16 inches in ½ of a 55-gallon oil drum. This measurement rated good.
	4					
Mannford (near)	3			(?)	13+	W. S. Taylor, on farm 1 mile north of Mannford, measured 13 inches before storm ended on September 4, 1940. He estimates that at least 2 inches more fell after his measurement. U. S. E. D.
	4					
Do	3			6:30 a	9.40	Jim Hinton, 5 miles southwest of Mannford on State Highway No. 33, caught a No. 2 tub full (rainfall equivalent of 9.4 inches) before 6:30 a. m. on Wednesday, Sept. 4, 1940. Cottonwood creek 2 feet above bridge at this point—not much crop damage, however. U. S. E. D.
	4					
Mounds	3			End of storm	14.00	C. G. Weller, Phillips Petroleum Station, Mounds, Okla., measured 14 inches. This is a good measurement.
	4					
Mounds (near)	3	DN		Noon	12.00	Mr. Tom Bacon, on small farm 1 mile south of Mounds P. O., has been measuring rainfall for a number of years. He has a straight-sided can mounted on a post 5 feet above the ground and well exposed. Mr. Tom Bacon reported 12 inches of rain for the 24-hour period ending at noon on Sept. 4, 1940. This is a very reliable record.
	4		Noon			
Oilton	3			(?)	9.6+	Mr. C. L. Diehmel, Oilton, Okla., reported that a No. 3 tub (rainfall equivalent of 9.6 inches) ran over early Wednesday morning. U. S. E. D.
	4					
Oilton (near)	3			End of storm	17.00	C. D. Wortham, located 5½ miles east of Oilton on Highway No. 33, measured 17 inches in ½ of a 55-gallon oil drum. U. S. E. D.
	4					
Do	3			8:00 a	9.6+	Frank Johnson, 6 miles east of Oilton on Highway No. 33, reported that a No. 3 tub (rainfall equivalent of 9.6 inches) ran over at 8 a. m. on Wednesday morning. U. S. E. D.
	4					

[1] Measured rainfall from 8 a. m. to noon.

TABLE 1.—*Observed precipitation and other notes, storm of September 3–4, 1940*—Continued

Station	Date: September 1940	Began	Ended	Observed at	Amount, inches	Remarks
Creek County—Continued.						
Red Fork (near)	3			11:00 a	9.6+	H. Stanis, located 7 miles south and ½ mile east of Red Fork, reports that a No. 3 tub ran over about 11 a. m. on Wednesday. U. S. E. D.
	4					
Rock Creek (near)	3	DN		(?)	13+	Fred Graham, located 7 miles south of Rock Creek P. O., reported that a 5 gallon can 13 inches high with straight sides ran over, may have lost about 1 inch. U. S. E. D.
	4		3:30 p.			
Sapulpa	2	DN	DN	7:30 a		Weather Bureau observer. 8 inch standard nonrecorder. Gage at city waterworks. Rain began on Tuesday night and ended Wednesday at 3 p. m. Rock Creek flooded. Pumping plant, located on high bank next to Rock Creek, flooded; water about waist deep all around plant. Water level reached top of box support of rain gage, however, gage functioned. Part of U. S. Highway 66 just north of pumping plant washed out.
	3	DN		7:30 a	.80	
	4		3:00 p.	7:30 a	7.80	
	5			7:30 a	7.70	
Sapulpa (near)	3	Mid't.		3:00 p	14.00	J. B. Henderson Salvage Co., ¾ mile west of Sapulpa, caught 14 inches in an iron kettle (14 inches is computed amount of catch in iron kettle). U. S. E. D.
	4		3:00 p.			
Do	3	DN		11:00 a	8.7+	A. L. Steeples, located 3 miles east and 2 miles north of Sapulpa, caught a No. 2 tub full at 11 a. m. Wednesday morning. Rainfall equivalent of a No. 2 tub is 8.7 inches. Probably rained 3 inches more after 11 a. m. on Sept. 4. U. S. E. D.
	4		P. m.			
Kay County:						
Chilocco	2			Late p. m	0	Observations made by Chilocco Indian School. Weather Bureau standard nonrecorder. Observer reports that steady rain fell from 6 a. m. to 10:30 a. m. on Sept. 4.
	3	Mid't.		do	.49	
	4		1:00 p.	do	6.32	
Dilworth (near)	3	DNA		After storm	6.00	Mr. Giblen, located 1 mile north of Dilworth on farm, Sec. 32, T. 29 N., R. 1 E., reported 6 inches rainfall, measured in a straight-sided can. Reliable measurement. Heaviest rain fell around 5 a. m. on Sept. 4.
	4		11:00 a.			
Do	3	DNA		do		Reported by Soil Conservation Service Flood Control Survey, Blackwell, Okla., 1½ miles SW. of Dilworth. Measured in a straight-sided can.
	4		Noon		3.50	
Kildare (near)	2	Noon	4:00 p.	7:00 a	0	Mr. Owens, located at Ponca City Lake, 2 miles east of Kildare, Okla., 8-inch standard U. S. W. B. tube type nonrecorder. Gage is operated by Ponca City water department, Ponca City, Okla.
	3	DNA		7:00 a	2.24	
	4		4:00 p.	7:00 a	8.14	
	5			7:00 a	.28	
Do	3	DNA		After storm	5.00	Guy Ray, located on farm 6 miles west and 1½ miles north of Kildare, Okla., Sec. 14, T. 27 N., R. 1 E., measured 5 inches in a straight sided bushel measure.
	4		P. m.			
Newkirk	3	DNA		7:00 a	.90	Weather Bureau observer. Eight-inch standard nonrecorder.
	4		Noon	7:00 a	3.76	
	5			7:00 a	2.55	
Peckham (near)	3	DNA		End of storm	6.00	Reported by Soil Conservation Flood Control Survey, Blackwell, Okla., 1 mile south of Peckham. Measured in straight-sided bushel measure. Heaviest rain from 6 to 9 a. m. on Sept. 4.
	4		Noon			
Ponca City	2	12:30 p.	4:00 p.	6:00 p	.53	Weather Bureay airway station at Ponca City Airport. 8-inch standard nonrecorder.
	3	1:30 p.	3:40 p.	6:00 p	.80	
	4	2:10 a.	1:45 p.	6:00 p	2.61	
	5			6:00 p	0	
Okmulgee County:						
Bald Hill (near) (SCS No. 2).	3	4:00 p.		8:00 a	0	C. C. C. Camp, SCS–14–OK, Morris, Okla. Gage located 2½ miles SW. of Bald Hill in Section 7, Twp. 14 N., R. 14 E. 8-inch standard nonrecorder.
	4		P. m.	8:00 a	2.67	
	5			8:00 a	1.07	
Beggs	3			End of storm	10.00	Postmaster at Beggs reported that several farmers and men in town measured around 10 inches in straight-sided cans. Reliable information.
	4					
Do	3			do	10.50	Water department of Beggs, estimated and partly measured 10.5 inches. U. S. E. D.
	4					
Beggs (near)	3			do	12.50	S. J. Baker, located on farm 4 miles north of Beggs, measured 12.5 inches in an oil drum. U. S. E. D.
	4					
Do	3			do	10.50	Mr. Naylor, 3¼ miles west of Beggs, measured 10.5 inches. This is an extra good measurement. Reliable. U. S. E. D.
	4					
Morris (SCS No. 1)	3	4:00 p.		8:00 a	0	C. C. C. Camp, SCS–14–Ok, Morris, Okla. Gage located within city limits of Morris. 8-inch standard nonrecorder. No damage. Lowlands to SW. flooded slightly, especially where small Goose Creek runs into Deep Fork River.
	4		P. m.	8:00 a	1.70	
	5			8:00 a	1.80	
Natura	3			End of storm	9.50	Mr. Hacker, school teacher at Natura, measured 9.5 inches. U. S. E. D.
	4					
Natura (near)	3			do	10.00	George Pickering, 2 miles north of Natura, measured 10 inches during storm. U. S. E. D.
	4					
Do	3			do	6.50	Two road workers, 3 miles south of Natura, reported they measured 6.5 inches of rain in a No. 8 lard bucket.
	4					
Do	3			do	11.50	Mr. Harton, 1 mile north of Natura, measured 2 inches from top of a 5 gallon oil bucket, or 11.5 inches. U. S. E. D.
	4					
Do	3			do	10.50	Sal Burch, 3 miles north and 1 mile east of Natura, measured 10.5 inches. U. S. E. D.
	4					
Okmulgee	3	3:00 a.		7:00 a	3.55	Weather Bureau observer. 8 inches standard nonrecorder. Gage located 1½ miles west of town on State Highway No. 27. Gage is at city waterworks plant. Deep Fork River runs beside plant and was bank-full, very little overflow into fields and low areas. Okmulgee was cut off from Tulsa to the north.
	4		About 7:00 a	7:00 a	2.46	
	5			7:00 a	.06	
Slick (near)	3			End of storm	7.00	Jennings Service Station, 4 miles east of Slick, measured 7 inches in a No. 2 coffee can. U. S. E. D.
	4					
Osage County:						
Herd	3			7:30 a	0	Weather Bureau observer. 8-inch standard nonrecorder.
	4			7:30 a	.54	
	5			7:30 a	.93	
Hominy	2	(?)		6:30 p	.02	Do.
	3	10:00 a.[3]		6:30 p	.31	
	4		5:00 p.	6:30 p	3.87	
		6:30 p.	7:30 p.			
	5			6:30 p	.01	
Hominy (near)	3	DN		End of storm	6.00	C. R. Manor, on farm 12 miles east and 1 mile south of Hominy on Skiatook highway, measured 6 inches in straight-sided can.
	4		P. m.			
Pawhuska	2	3:30 p.		6:00 p	1.44	Weather Bureau observer. 8-inch standard nonrecorder.
	3			6:00 p	.66	
	4		Late p. m.	6:00 p	2.64	

[3] Thundershower.

[3] Mist.

TABLE 1.—*Observed precipitation and other notes, storm of September 3–4, 1940*—Continued

Station	Date: September 1940	Began	Ended	Observed at	Amount, inches	Remarks
Osage County—Continued.						
Shidler (near)	3	P. m.		End of storm	4.00	Texaco Oil Co. plant, 4 miles south of Shidler, reported 4 inches caught in gallon can. Not much run-off in this area; no heavy rain. Light rains on Tuesday night and Wednesday.
	4		Late p. m.			
Skiatook (near)	3	P. m.		do	5.50	Mrs. P. V. Daniel, 3½ miles west of Skiatook on State Highway No. 20, measured 5.5 inches in a straight-sided, well exposed can. Record very good.
	4		Late p. m.			
Wynona	3	DN		do	5.00	5 inches reported from several fairly reliable sources in city of Wynona.
	4		Late p. m.			
Pawnee County:						
Cleveland	3	DNA		6:00 p	.35	Weather Bureau observer. 8-inch standard nonrecorder. Great deal of run-off in this area, especially a few miles west of Cleveland. Cleveland dam failed, due to flood waters; part of highway bridge below dam on U. S. Highway No. 64 washed out.
	4		4:00 p.	6:00 p	6.57	
Cleveland (near)	3			End of storm	18.50	John Bycek, located 8 miles west of Cleveland on U. S. Highway No. 64, measured 18.50 inches. U. S. E. D.
	4					
Do	3			10:00 a	8.7+	M. H. Moore, 6 miles east and 1¾ miles south of Cleveland, caught a No. 2 tub full at 10:30 a. m. on the 4th; rainfall equivalent of No. 2 tub is 8.7 inches. U. S. E. D.
	4					
Do	3			End of storm	9.00	J. M. Richards, at Johnson Refinery ¾ mile west of Cleveland, measured 9 inches in a straight-sided container. U. S. E. D.
	4					
Do	3			(?)	8.7+	Deems Station, 1½ miles west of Cleveland, measured at No. 2 tub full rainfall equivalent of 8.7 inches.
	4					
Hallett	3			End of storm	19.75	Clark Moore at Hallett, 2 blocks west of paved highway, measured 19.75 inches after storm ended. U. S. E. D.
	4					
Keystone	3			5 days after storm	8.00	W. H. Kurtz, DX Service Station at Keystone, measured 8 inches in a straight sided barrel. Measurement made 5 days after rain ended U. S. E. D.
	4					
Keystone (near)	3			End of storm	11.00	George Millstom, 3 miles west of Keystone on bank of Cimarron River measured rainfall in straight-sided can. Good. U. S. E. D.
	4					
Do	3			do	11.00	George S. Thomas, on Farm 2 miles west of Keystone, measured 11 inches in ½ of a 55-gallon drum. Good. U. S. E. D.
	4					
Do	3			do	9.75	J. N. Woodfin, 3½ miles northwest of Keystone of U. S. Highway No. 64. measured 9.75 inches in a bucket. Good. U. S. E. D.
	4					
Maramec (near)	3			do	19.00	Mr. Wisely, ½ mile south of west side of Maramec, measured 19 inches in a straight-sided container. Mr. Wisely has been in Civil Service and seems very reliable. U. S. E. D.
	4					
Do	3			10:30 a	18.75+	W. C. Carpenter, 2 miles south of Maramec, measured 18.75 inches in a straight-sided cream can, which ran over at 10:30 a. m. on the 4th. U. S. E. D.
	4					
Do	3			End of storm	14.00	C. D. Ryan, 2 miles east and 2 miles north of Maramec, estimated 14 inches, measured in an oil drum, which was protected slightly by house. U. S. E. D.
	4					
Pawnee	3			do	6.50	F. A. Hrabe, hardware store at Pawnee, measured 6½ inches in rain gage. Good record. U. S. E. D.
	4					
Pawnee (near)	3			7:30 a	8.7+	C. C. Talbert, 4 miles south and 6 miles east of Pawnee, reported that a No. 2 tub (rainfall equivalent of 8.7 inches) ran over at 7:30 a. m. on Sept. 4, 1940. U. S. E. D.
	4					
Ralston	2	2:30 p.	4:30 p.	Early a. m	0	Weather Bureau observer. 8-inch standard nonrecorder. Arkansas River at Ralston up to gage height of 9 feet at peak; river rose about 4.5 feet.
	3	9:00 a.		Early a. m	.16	
	4		2:00 p.	Early a. m	4.60	
	5			Early a. m	3.54	
Ralston (near)	3	A. m.		End of storm	8.00	F. Pipe Stem, 4 miles south of Ralston on farm, caught 8 inches in a straight-sided can. Reliable. Great deal of run-off in this area. All small creeks flooded. Not much crop damage, however, as land has considerable slope in this locality.
	4		Early p. m.			
Payne County:						
Yale	3			do	7.70	W. E. Christman in Yale, measured rainfall in a No. 2 tub. Tub was filled to within 1 inch of top; rainfall calculated as 7.7 inches.
	4					
Yale (near)	3			do	16.50	J. L. Ellis, 2½ miles east and 1 mile north of Yale, measured 16.5 inches in an oil barrel. U. S. E. D.
	4					
Tulsa County:						
Bixby (near)	3			do	11.00	R. E. Burnby, ½ mile south of Bixby, measured 11 inches in a straight-sided can. U. S. E. D.
	4					
Do	3			do	14.00	Ray O'Hern, 5 miles south of Bixby, measured 14 inches in a stock tank. U. S. E. D.
	4					
Do	3			(?)	14.50+	Tom Madison Grocery, 4 miles south and 7 miles west of Bixby, measured 14.5 inches and Mr. Madison said possibly an inch ran over. U. S. E. D.
	4					
Do	3			End of storm	9.50	Snake Creek Store, 4 miles south of Bixby, measured 9½ inches in a straight-sided tub. U. S. E. D.
	4					
Do	3			do	13.00	Brown's Grocery Store, 7 miles south and 2 miles west of Bixby, measured 13 inches in an oil drum. Snake, Duck & Euchee Creeks did a lot of damage at this point. U. S. E. D.
	4					
Broken Arrow (SCS No. 1)	3			5:00 p	0	C. C. C. camp, SCS–Ok–22, located at Broken Arrow. 8 inch standard non-recorder. No flash or heavy rains.
	4	12:01 a.	3:30 p.	5:00 p	4.51	
	5	8:15 a.	9:30 a.	5:00 p	.29	
Broken Arrow (near)	3			End of storm	7.00	Mr. E. C. Carter, 5 miles west of Broken Arrow, measured 7 inches in a gallon bucket. U. S. E. D.
	4					
Collinsville	3	DNA		do	2.00	Santa Fe ticket agent at Collinsville estimated 2 inches for storm and reported this amount to the railroad company. A slow steady rain.
	4		P. m.			
Jenks (near)	3			do	17.00	W. F. Young, 2 miles west and 1¼ miles south of Jenks, had bucket which measured 0.85 foot deep, 0.93 foot across top and 0.76 foot at bottom. Bucket caught full twice. Rainfall equivalent for 2 buckets full is 17 inches.
	4					
Oneta (near), (SCS No. 2)	3			6:00 p	.20	C. C. C. camp, SCS–Ok–22, Broken Arrow, Oklahoma. Gage located 5 miles southwest of Oneta. 8 inch standard nonrecorder.
	4	2:00 a.	4:00 p.	6:00 p	6.10	
	5			6:00 p	.28	
Skiatook	3	A. m.		End of storm	5.00	C. F. Rodgers, Skiatook, Oklahoma, measured 5 inches in a 50-gallon drum well exposed. He measured all rainfall. Good record. Bird Creek about ½ bank-full at Skiatook.
	4		A. m.			
Tulsa (city)	3	3:15 p.		Early a. m	.08	Weather Bureau observer. 8 inch standard nonrecorder.
	4		10:30 a.	Early a. m	3.38	
	5			Early a. m	4.11	
	6			Early a. m	.65	

TABLE 2.—*Hourly rainfall amounts (inches) at Tulsa Airport, September 3–4, 1940*

Hour	Third a. m.	Third p. m.	Fourth a. m.	Fourth p. m.
1	0	0	0.11	0.22
2	0	0	.22	.15
3	0	0	.34	.02
4	0	0	.30	.01
5	0	.01	.26	.01
6	0	.05	.17	.02
7	0	0	.15	0
8	.03	0	.19	0
9	0	0	.24	0
10	0	0	.21	0
11	0	0	1.61	0
12	0	.06	1.98	0

FLOOD-STAGE REPORT FOR SEPTEMBER 1940

[All dates in September unless otherwise specified]

River and station	Flood stage	Above flood stages—dates		Crest	
		From—	To—	Stage	Date
ATLANTIC SLOPE DRAINAGE					
	Feet			*Feet*	
James: Columbia, Va	10	Aug. 31	3	16.0	1
Saluda: Pelzer, S. C	6	1	1	6.9	1
Catawba: Catawba, N. C	8	Aug. 30	2	16.0	Aug. 31
Santee:					
Rimini, S. C	12	1	3	13.4	3
Ferguson, S. C	12	(1)	3		
Savannah: Butler Creek, Ga	21	1	2	22.9	1
MISSISSIPPI SYSTEM					
Arkansas Basin					
North Canadian: Yukon, Okla	8	5	5	9.1	5
Arkansas: Tulsa, Okla	16	4	5	19.3	5

[1] Continued from preceding month.

ESTIMATED FLOOD LOSSES AND SAVINGS DURING 1938

By BENNETT SWENSON

[U. S. Weather Bureau, Washington, Oct. 1940]

The estimated flood losses during the year 1938 (table 1) total $101,099,645. The average annual loss for the years 1924 to 1938, inclusive, is approximately $105,000,000. The greatest annual loss during this period occurred in 1937 with a total estimated loss of approximately $482,000,000, and the least in 1931 with a total of about $2,800,000.

The outstanding floods during the year, with estimated losses, were as follows:

Floods in New England during September caused damage amounting to about $37,000,000; early in March a total loss of approximately $24,500,000 occurred during the severe floods in southern California; and in July a loss of more than $5,000,000 was reported from floods in the Colorado River in Texas.

The reported savings as the result of flood warnings during the year, shown in table 2, reach a total of more than $11,000,000.

TABLE 1.—*Estimated flood losses during 1938*

River and drainage	Tangible property totally or partially destroyed	Matured crops	Prospective crops	Livestock and other movable farm property	Suspension of business	Total
ST. LAWRENCE						
Maumee River			$2,600			$2,600
Rivers in southeastern Michigan						119,350
Saginaw River	$9,350		11,900	$550	$1,000	22,800
Grand River	90,100			700	4,400	95,200
ATLANTIC SLOPE						
Merrimack River						[1] 6,000,000
Connecticut River	23,673,000		[2] 1,923,000			[1] 25,596,000
Mohawk River						100,000
Hudson River						5,220,000
Susquehanna River	130,900	$10,210	3,090	1,000	7,025	152,225
Roanoke River	5,000	11,000	281,000		46,000	343,000
Neuse River	3,800	1,000	35,200	600	3,500	44,100
Cape Fear River			2,750	250	1,000	4,000
Tar River			28,500		2,000	30,500
Savannah River				650	4,750	5,400
Altamaha River	7,000	200	8,000	3,600	9,000	27,800
EAST GULF OF MEXICO						
Apalachicola River	4,100		3,300	3,650	10,250	21,300
Pea River	37,500					37,500
Choctawhatchee River	47		3,000			3,047
Conecuh River	23,300	220	12,600		1,900	38,020
Alabama River	375,000	12,700	276,000	17,600	221,000	902,300
Black Warrior and Tombigbee Rivers	40,400	500	2,450	4,060	45,000	92,410
Pascagoula River	145,000	3,700	86,000	9,000	25,000	268,700
Pearl River	95,000	2,300	165,000	5,300	24,000	291,600
UPPER MISSISSIPPI BASIN						
Chippewa River	72,000	5,000	20,000	15,000		112,000
Whitewater and Zumbro Rivers	80,000	40,000		2,000		122,000
Black River (Wis.)	52,000	15,000				67,000
Root River (Minn.)	10,000	10,000				20,000
Wisconsin River	204,315	524,150	155,600	13,535	42,100	939,700
Turkey River	26,200					26,200
Rock River	440,000	245,000	35,000	31,000	45,000	796,000
Cedar-Iowa Rivers	1,000	1,500			1,000	3,500
Des Moines River	9,750	58,750	3,800	250	300	72,850
Illinois River	15,200					15,200
Mississippi River above Cairo, Ill	1,164,250	125,800	148,300	2,940	43,560	1,484,850
MISSOURI BASIN						
Rivers in Montana						1,039,000
Rivers in Colorado	679,000					679,000
Fall River in South Dakota	25,000					25,000
Big Sioux River	25,000		86,000	5,000		116,000
Smoky Hill River	425,000		440,000	18,000	11,000	894,000
Republican River	7,000		6,000			13,000
Osage River	15,000	100,000	181,000	2,200	7,000	305,200
Missouri River	165,785	137,500	942,000	12,100	4,550	1,261,935
OHIO BASIN						
Muskingum River		5,500	13,000		5,000	23,500
Scioto River			3,200			3,200
Green River			10,000			10,000
Wabash River	171,130	275,200	3,596,750	6,200	188,100	4,237,380
North Fork of Holston River	15,000		700			15,700
Wautauga River (Brush Creek)	100,000	5,000			1,000	106,000
Little Pigeon and Little Rivers	62,000		8,000	15,000		85,000
WHITE BASIN						
Black River	17,000		500	200	6,000	23,700
White River	99,000	8,700	25,800	9,200	24,900	167,600
ARKANSAS BASIN						
Little Arkansas River	2,000	5,000	500		2,000	9,500
Walnut River			210,000			210,000
Ninnescah River	26,200		29,600	300		56,100
Verdigris River	5,000		105,000			110,000
Cottonwood River	4,450	6,000	180,000	3,200	10,000	203,650
Neosho River	94,350	120,346	455,500	25,500	57,460	753,156
North Canadian River	80,100	500	10,050		100	90,750
South Canadian River						50,000

[1] Furnished by U. S. Engineer Office.
[2] Including all agricultural losses.

TABLE 1.—*Estimated flood losses during 1938*—Continued

River and drainage	Tangible property totally or partially destroyed	Matured crops	Prospective crops	Livestock and other movable farm property	Suspension of business	Total
ARKANSAS BASIN—con.						
Petit Jean River	$600				$600	$1,200
Arkansas River	168,850	$90,300	$133,900	$30,900	103,000	526,950
RED BASIN						
Little River	1,150		35	695		1,880
Sulphur River	21,500	3,000	550	8,100	9,400	42,550
Cypress River	7,500			150	500	8,150
Ouachita River						82,400
Red River	326,850	16,700	138,000	104,500	33,800	619,850
LOWER MISSISSIPPI BASIN						
St. Francis River			1,000			1,000
WEST GULF OF MEXICO						
Sabine River	2,700		1,500	500	2,700	7,400
Trinity River	154,545	11,680	176,340	35,225	41,504	419,294
Brazos River	10,000					10,000
Colorado River	1,800,000	200,000	3,195,000	5,000		5,200,000
Guadalupe River	10,000	72,000	152,000	2,140		236,140
Rivers in Eastern New Mexico	108,500	4,000	3,000		1,000	116,500
Rio Grande	10,800	100	2,725	200		13,825
COLORADO BASIN						
Gunnison River	11,800			500	850	13,150
Miscellaneous rivers in Arizona	31,083				50,000	81,083
Oak Creek	60,000					60,000
Verde-Salt-Gila Rivers	102,500					102,500
PACIFIC SLOPE						
Rivers in Southern California						24,500,000
Kings, Tulare & Kaweah Rivers						10,875,000
San Joaquin River	150,000		341,150	2,200		493,350
Sacramento River	752,200	691,650	1,406,400	58,750	403,500	3,312,500
Eel River	3,000	3,500			12,500	19,000
Willamette River	5,500	2,000	500	1,000		9,000
Columbia River						781,400
Grand total						101,099,645

TABLE 2.—*Reported savings resulting from flood warnings during 1938*

ST. LAWRENCE DRAINAGE	
Grand River	$6,225
ATLANTIC SLOPE DRAINAGE	
Merrimack River	[1] 700,000
Connecticut River	[1] 2,000,000
Hudson River	[1] 300,000
Susquehanna River	55,350
Roanoke River	135,000
Neuse River	39,500
Cape Fear River	9,000
Tar River	7,500
Savannah River	15,000
Altamaha River	24,000

[1] Estimated.

TABLE 2.—*Reported savings resulting from flood warnings during 1938*—Continued

EAST GULF OF MEXICO	
Apalachicola River	$28,500
Conecuh River	15,750
Alabama River	400,000
Black Warrior-Tombigbee Rivers	67,100
Pascagoula River	193,000
Pearl River	75,500
UPPER MISSISSIPPI BASIN	
Chippewa River	50,000
Whitewater and Zumbro Rivers in Minnesota	10,000
Black River in Wisconsin	10,000
Root River in Minnesota	10,000
Wisconsin River	203,500
Turkey River in Iowa	6,000
Rock River in Illinois	40,000
Des Moines River	16,600
Mississippi River above Cairo, Ill	141,950
MISSOURI BASIN	
Smoky Hill River in Kansas	140,000
Osage River in Kansas	5,000
Missouri River	634,300
OHIO BASIN	
Muskingum River	5,000
Wabash River	437,200
WHITE-ARKANSAS BASIN	
Black River in Missouri	65,000
White River in Arkansas	1,354,100
Little Arkansas River	1,000
Cottonwood River in Kansas	5,000
Neosho River	80,000
North Canadian River	1,000
Arkansas River	406,000
RED BASIN	
Little River in Arkansas	2,275
Sulphur River in Texas	63,000
Cypress River in Texas	600
Ouachita River	160,700
Red River	163,500
LOWER MISSISSIPPI BASIN	
Tallahatchee River in Mississippi	5,000
WEST GULF OF MEXICO	
Guadalupe River	56,250
Sabine River	1,000
Trinity River	346,780
Colorado River in Texas	850,000
GULF OF CALIFORNIA	
Gunnison River	101,000
Verde-Salt-Gila Rivers	4,500
PACIFIC SLOPE	
Sacramento River	2,002,000
Columbia River	25,000
Total	11,474,680

CLIMATOLOGICAL DATA

[For description of tables and charts, see REVIEW, January, pp. 32 and 38]

CONDENSED CLIMATOLOGICAL SUMMARY OF TEMPERATURE AND PRECIPITATION BY SECTIONS

In the following table are given for the various sections of the climatological service of the Weather Bureau the monthly average temperature and total rainfall; the stations reporting the highest and lowest temperatures, with dates of occurrence; the stations reporting the greatest and least total precipitation; and other data as indicated by the several headings.

The mean temperature for each section, the highest and lowest temperatures, the average precipitation, and the greatest and least monthly amounts are found by using all trustworthy records available.

The mean departures from normal temperatures and precipitation are based only on records from stations that have 10 or more years of observations. Of course, the number of such records is smaller than the total number of stations.

Section	Temperature							Precipitation					
			Monthly extremes							Greatest monthly		Least monthly	
	Section average	Departure from the normal	Station	Highest	Date	Station	Lowest	Date	Section average	Departure from the normal	Station	Amount	Station	Amount
	°F.	°F.		°F.			°F.		In.	In.		In.		In.
Alabama	73.7	−2.0	3 stations	100	3	2 stations	36	[1] 27	1.47	−2.05	Mobile	4.86	Bridgeport	0.12
Arizona	72.6	−.2	Mohawk	111	10	Alpine	29	25	2.76	+1.43	Truxton	7.43	Yuma	.53
Arkansas	71.2	−3.2	Conway	100	9	Gilbert	31	12	1.83	−1.48	Fayetteville	8.44	Fulton	.08
California	65.6	−2.0	El Centro	113	10	Twin Lakes	20	19	.40	−.07	Elk Valley	4.89	76 stations	.00
Colorado	60.6	+2.5	Sedgwick	102	8	Pearl	21	11	2.79	+1.42	Trickle Park	7.29	Garnett	.56
Florida	77.3	−2.1	De Funiak Springs	99	[1] 3	Mason	42	12	6.72	+0.5	Homestead	21.80	Mount Pleasant	.62
Georgia	72.9	−2.5	Blakely	102	23	Blairsville	31	28	1.04	−2.56	Glennville	3.65	Carlton Bridge	.04
Idaho	59.3	+2.2	Orofino	102	7	Pelton's Ranch	15	[1] 29	3.32	+2.25	Big Creek	7.05	Clark Fork	.55
Illinois	66.6	−1.3	Carbondale	102	21	7 stations	29	[1] 26	.64	−3.01	Casey	2.78	Hardin	.00
Indiana	65.2	−2.0	Shoals	102	22	Winona Lake	28	25	1.17	−2.15	Tell City	3.17	Gary	.17
Iowa	65.8	+1.9	Logan	98	[1] 7	2 stations	27	[1] 12	.94	−2.82	Waterloo	4.07	2 stations	T
Kansas	70.5	+.7	3 stations	102	[1] 1	Centralia	29	26	2.50	−.27	Arkansas City	8.45	Wheaton	.39
Kentucky	66.7	−3.8	Lovelaceville	100	21	Clermont	29	[1] 27	1.97	−.94	Pippapass	4.67	2 stations	.45
Louisiana	75.2	−2.8	New Orleans (Audubon).	101	10	Tallulah	39	12	3.74	−.11	Ville Platte (near)	10.82	Minden	.30
Maryland-Delaware	64.5	−3.2	Dundalk, Md	95	21	Oakland, Md	25	27	3.31	−.07	Frederick, Md	7.20	Snow Hill, Md	1.00
Michigan	60.0	+.3	Monroe	95	20	Roscommon	24	26	2.35	−.96	Roscommon	5.22	Channing	.14
Minnesota	62.6	+3.4	2 stations	95	[1] 7	3 stations	22	[1] 25	1.01	−1.79	Duluth	3.47	Farmington	.10
Mississippi	73.3	−2.6	do	99	[1] 2	do	38	[1] 12	2.40	−.62	Pearlington	6.57	Scott	.32
Missouri	68.8	−.6	Sikeston	100	9	2 stations	28	[1] 26	.69	−3.29	Neosho	4.07	4 stations	.00
Montana	61.2	+5.9	2 stations	103	3	Outlook	19	10	1.86	+.52	Birch Creek Camp	6.51	Sentinel Butte Pass	.04
Nebraska	69.1	+4.7	Niobrara	107	18	Nenzel (near)	21	11	1.22	−.80	Madrid	3.85	Ord	.07
Nevada	61.2	−.1	Overton	109	16	2 stations	22	[1] 27	1.13	+.69	Charleston Mt. R. S.	4.01	Goldfield	.00
New England	58.9	−1.3	Mount Carmel, Conn.	90	21	Presque Isle, Maine	22	27	3.98	+.15	2 stations	9.00	Amherst, Mass	1.53
New Jersey	63.5	−2.3	Elizabeth	93	20	Charlotteburg	25	27	4.41	+.62	Clayton	11.95	Tuckerton	1.17
New Mexico	65.3	+.9	Orogrande	102	5	Elizabethtown	27	27	1.52	−.17	Irvin's Ranch	5.35	3 stations	.00
New York	59.1	−2.0	4 stations	89	[1] 20	Whiteface Mountain.	20	26	3.37	−.11	Greene	6.74	Massena	1.34
North Carolina	68.1	−2.9	Shelby	99	22	2 stations	24	[1] 27	1.48	−2.46	Hatteras	4.75	Marion	.10
North Dakota	62.8	+5.9	2 stations	103	3	do	20	[1] 11	1.06	−.44	Pembina	3.00	Mayville	.02
Ohio	62.9	−2.8	Van Wert	99	20	Lima	27	26	1.54	−1.42	Willoughby	3.96	Larue	.56
Oklahoma	72.9	−1.4	Alva	106	9	2 stations	35	[1] 26	2.83	−.26	Sapulpa	16.30	Ardmore	.20
Oregon	58.9	+1.1	Umatilla	102	9	Fremont	21	5	2.87	+1.66	Wicopee	6.88	Umatilla	.44
Pennsylvania	61.4	−2.8	Marcus Hook	95	20	Kane Airway Station.	21	26	3.41	+.02	Pottsville	6.97	Hollidayburg	1.27
South Carolina	72.4	−2.0	Little Mountain	101	22	2 stations	35	27	1.39	−2.65	Effingham	4.83	Crescent	.00
South Dakota	67.1	+5.4	Armour	107	7	Britton	21	25	.75	−.74	Waters Ranch	2.86	Gettysburg	T
Tennessee	68.7	−2.8	Etowah	100	22	Gatlinburg	30	28	1.07	−1.93	Covington	3.07	Charleston	.18
Texas	75.9	−1.4	Memphis	107	9	Muleshoe	39	[1] 26	1.40	−1.49	Galveston	6.87	4 stations	.00
Utah	61.8	+1.0	Green River	103	1	Silver Lake	26	[1] 27	2.72	+1.66	Cedar Breaks	6.93	Utah Lake (Lehi)	.61
Virginia	65.3	−3.4	Lincoln	96	21	2 stations	27	[1] 27	1.57	−1.51	Winchester	4.88	Wytheville	.30
Washington	62.7	+4.6	Wahluke (near)	104	9	Stockdill Ranch	28	20	2.03	+.19	Anatone	5.77	Sixprong	.38
West Virginia	62.2	−4.2	Glenville	98	20	2 stations	21	[1] 12	2.88	−.02	Belington	5.63	White Sulphur Springs	.50
Wisconsin	61.4	+1.0	Eau Claire	96	19	3 stations	23	26	1.24	−2.40	Antigo	4.20	Darlington	.16
Wyoming	59.1	+4.3	3 stations	102	[1] 1	Border	20	16	2.29	+1.14	Quaking Aspen Creek.	5.20	Colony	.57
Alaska [August]	54.3	+1.6	Ophir	85	1	Barrow	26	4	4.03	+.61	Little Port Walter	27.59	Tanana	.23
Hawaii	75.3	+.5	Mahukona	95	21	Haleakala	33	8	5.64	−.19	Kukui	34.00	3 stations	.00
Puerto Rico	79.2	+.7	2 stations	98	[1] 11	2 stations	59	[1] 15	6.21	−2.19	Villalba	15.21	Aibonito	.61

[1] Other dates also.

CLIMATOLOGICAL DATA FOR WEATHER BUREAU STATIONS

District and station	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max.+mean min.÷2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01 inch, or more	Wind: Average hourly velocity	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	*Ft.*	*Ft.*	*In.*	*In.*	*In.*	°F.	°F.	°F.		°F.	°F.		°F.	°F.	°F.	°F.	%	*In.*	*In.*		*Miles*								*0–10*	*In.*	*In.*
New England							**60.6**	**−0.2**										**83**	**3.75**	**+0.7**										**5.3**		
Eastport	75	67	85	29.89	29.97	−0.06	55.2	−0.6	76	1	62	38	26	49	23	52	51	90	6.85	+4.1	13	8.6	sw.	42	ne.	2	10	8	12	5.8	0.0	0.0
Greenville, Maine	1,070	6	----	28.85	30.01	----	53.4	----	78	1	65	28	30	42	38	49	49	----	4.41	----	14	----	----	----	----	----	----	----	----	----	----	----
Portland, Maine	103	82	117	29.87	29.98	−.07	60.0	+.4	80	3	68	39	26	52	24	55	52	86	3.92	+.8	11	7.4	n.	30	e.	2	13	11	6	4.6	.0	.0
Concord [1]	289	54	72	29.70	30.02	−.04	59.4	+.1	82	20	71	30	27	47	37	53	50	84	3.73	+.3	9	4.7	n.	19	nw.	22	12	10	8	4.8	.0	.0
Burlington	403	11	48	29.58	30.01	−.05	58.2	−2.1	76	18	67	35	30	49	27	53	50	80	2.54	.0	10	6.2	s.	25	s.	24	6	8	16	6.7	.0	.0
Northfield	876	12	60	29.08	30.03	−.03	55.5	−.6	77	20	67	32	26	44	33	48	47	90	5.52	+2.4	8	6.0	sw.	21	ne.	6	5	9	16	7.1	.0	.0
Boston [1]	124	106	165	29.88	30.01	−.06	63.3	+.1	86	21	71	42	26	55	24	56	52	74	2.32	−.8	11	9.8	nw.	33	ne.	2	12	8	10	5.0	.0	.0
Nantucket	12	14	90	30.00	30.01	−.07	62.7	−.1	78	2	69	45	27	57	19	58	56	84	5.23	+2.8	11	13.2	sw.	57	ne.	2	13	4	13	5.5	.0	.0
Block Island	26	11	46	30.00	30.02	−.06	63.3	−.1	79	2	70	45	27	57	20	58	56	80	2.85	+.2	7	13.0	sw.	38	n.	26	18	7	5	3.4	.0	.0
Providence [2]	159	65	25	29.86	30.03	−.04	63.9	+.7	87	21	74	39	27	54	30	56	54	82	2.57	−.6	9	10.5	nw.	35	nw.	21	11	8	11	5.1	.0	.0
Hartford [1]	159	122	----	29.86	30.03	−.04	61.4	−.3	88	21	74	32	27	49	37	56	54	84	2.37	−1.1	6	7.0	s.	29	n.	6	8	10	12	5.8	.0	.0
New Haven [2]	107	74	68	29.92	30.04	−.03	63.6	+.1	88	21	73	38	27	55	29	57	54	79	3.33	−.2	5	7.9	n.	27	sw.	25	14	8	8	4.7	.0	.0
Middle Atlantic States							**65.4**	**−1.5**										**76**	**2.78**	**−0.5**										**4.5**		
Albany [1]	97	26	40	29.92	30.02	−.05	60.0	−3.1	82	21	72	35	27	48	36	54	51	81	4.31	+1.2	7	6.2	s.	22	s.	24	8	12	10	5.7	.0	.0
Binghamton	871	57	79	29.14	30.07	.00	60.0	−1.3	84	20	71	31	27	48	35	53	51	82	1.51	−1.6	8	5.0	e.	16	nw.	25	4	14	12	6.8	T	.0
New York	314	415	454	29.70	30.03	−.05	65.8	−1.0	87	21	74	42	26	58	27	58	53	69	3.22	−.2	5	11.6	n.	50	nw.	21	16	6	8	4.5	.0	.0
Harrisburg [1]	374	94	104	29.66	30.06	−.02	64.0	−1.8	90	21	75	36	27	53	35	57	54	80	3.46	+.4	8	5.8	w.	28	n.	21	13	12	5	4.3	.0	.0
Philadelphia [3]	114	174	367	29.93	30.05	−.03	67.4	−.6	90	21	76	44	26	59	28	59	56	77	4.58	+1.4	6	10.5	n.	41	n.	25	16	7	7	4.4	.0	.0
Reading	323	47	306	29.71	30.06	----	64.4	−1.9	90	21	75	37	27	54	32	57	53	72	3.66	+.4	5	7.7	nw.	38	n.	21	15	7	8	4.4	.0	.0
Scranton	805	72	104	29.19	30.05	−.02	60.6	−2.3	86	21	72	33	27	49	35	53	50	75	2.72	−1.4	7	5.2	n.	28	nw.	21	9	13	8	5.1	.0	.0
Atlantic City	52	37	172	29.98	30.04	−.03	66.6	−.2	90	21	74	44	26	59	26	60	57	75	1.55	−1.1	6	13.3	w.	41	ne.	30	12	9	9	4.9	.0	.0
Sandy Hook	22	10	57	30.01	30.04	----	66.4	−1.1	85	21	73	46	26	60	25	59	56	74	2.85	−.6	4	11.7	w.	48	nw.	21	15	7	8	4.2	.0	.0
Trenton	190	89	107	29.84	30.04	----	64.9	−2.0	90	21	74	40	27	56	29	58	54	72	6.17	+2.8	6	6.7	n.	24	n.	25	14	7	9	4.9	.0	.0
Baltimore [2]	123	100	215	29.93	30.06	−.02	68.2	−.3	94	21	77	43	26	59	27	59	54	66	1.32	−2.0	6	8.8	n.	36	nw.	25	16	8	6	4.2	.0	.0
Washington	112	62	85	29.94	30.06	−.02	66.8	−1.3	92	21	76	42	27	57	29	59	55	73	1.34	−1.9	5	5.3	nw.	24	nw.	25	17	7	6	4.2	.0	.0
Cape Henry	18	8	54	30.01	30.03	----	70.4	−1.4	92	10	77	53	26	64	31	64	61	76	3.50	+.6	6	13.3	ne.	57	n.	25	16	6	8	4.4	.0	.0
Lynchburg	686	144	184	29.35	30.09	+.01	67.4	−1.6	93	21	79	38	27	55	32	59	55	72	1.14	−2.2	3	5.8	n.	25	ne.	30	19	8	3	3.1	.0	.0
Norfolk [3]	91	80	125	29.95	30.05	−.01	70.4	−1.2	91	10	78	51	26	63	35	63	61	82	4.10	+.9	7	9.4	ne.	34	n.	25	12	8	10	4.9	.0	.0
Richmond [3]	144	11	52	29.91	30.06	−.01	67.9	−2.6	92	21	78	41	27	58	33	60	58	86	1.55	−1.7	4	6.7	ne.	28	ne.	25	16	8	6	4.2	.0	.0
Wytheville	2,304	49	55	27.71	30.10	+.03	61.2	−2.4	86	21	74	30	27	48	34	54	51	78	.30	−3.0	2	4.5	nw.	24	w.	10	20	7	3	3.0	.0	.0
South Atlantic States							**72.6**	**−0.7**										**79**	**1.68**	**−2.6**										**4.3**		
Asheville	2,253	89	104	27.77	30.09	+.02	65.2	+.2	89	21	78	35	28	52	35	57	54	78	.35	−2.7	3	5.5	nw.	22	nw.	25	16	10	4	3.6	.0	.0
Charlotte [2]	779	63	86	29.23	30.05	−.02	71.4	−.1	95	21	83	43	27	60	32	61	58	74	.55	−2.4	6	6.5	ne.	26	nw.	10	14	9	7	4.4	.0	.0
Greensboro [1]	886	6	56	29.14	30.08	----	68.2	----	92	21	80	39	27	56	32	60	58	82	1.60	----	5	7.2	ne.	34	sw.	10	17	9	4	3.5	.0	.0
Hatteras	11	5	50	30.00	30.01	−.05	72.3	−2.2	88	1	78	58	26	67	21	68	65	80	4.75	+.1	7	13.2	ne.	47	nw.	10	15	7	8	4.6	.0	.0
Raleigh [3]	376	103	146	29.66	30.05	−.02	70.0	−1.1	94	21	80	47	26	60	36	61	58	76	1.71	−1.9	4	8.6	ne.	32	nw.	10	19	8	3	3.4	.0	.0
Wilmington	72	73	107	29.95	30.02	−.03	72.4	−.7	92	22	81	52	26	64	31	66	64	80	1.96	−2.6	7	8.6	ne.	28	sw.	25	13	7	10	4.8	.0	.0
Charleston [3]	48	11	92	29.96	30.01	−.03	74.9	−1.7	91	22	82	51	27	68	22	66	64	83	2.16	−2.4	4	11.4	n.	32	n.	26	13	6	11	4.8	.0	.0
Columbia, S. C. [3]	347	70	91	29.67	30.04	−.01	73.8	−.7	96	22	85	48	26	63	28	64	61	73	1.18	−2.3	8	7.8	ne.	21	ne.	26	17	9	4	3.5	.0	.0
Greeneville, S. C	1,040	70	78	28.97	30.06	----	72.0	+1.4	95	22	83	44	27	61	29	----	----	----	.14	−3.5	1	6.2	ne.	23	sw.	25	18	9	3	3.5	.0	.0
Augusta [3]	182	62	77	29.83	30.02	−.03	74.3	−1.0	97	22	85	50	26	63	32	64	60	70	1.52	−1.8	5	5.4	ne.	23	w.	10	15	5	10	4.6	.0	.0
Savannah [3]	65	73	152	29.94	30.00	−.03	76.7	+.5	96	22	86	50	27	68	31	68	66	84	1.31	−4.1	5	9.1	ne.	25	e.	18	12	9	9	5.1	.0	.0
Jacksonville [3]	43	86	110	29.94	29.98	−.02	75.8	−2.5	93	1	84	54	27	68	23	69	67	84	2.87	−4.5	8	8.1	ne.	23	ne.	18	6	12	12	6.2	.0	.0
Florida Peninsula							**80.0**	**−0.7**										**86**	**11.24**	**+4.1**										**6.3**		
Key West [3]	21	10	64	29.87	29.89	−.05	81.4	−.8	92	2	87	71	4	76	15	77	75	83	11.88	+5.2	22	8.7	e.	27	sw.	8	7	10	13	6.1	.0	.0
Miami [3]	25	124	168	29.88	29.91	−.06	80.0	−.1	92	26	86	71	4	75	18	75	74	90	17.81	+9.5	21	7.7	ne.	24	s.	12	5	7	18	7.4	.0	.0
Tampa [3]	35	88	197	29.90	29.94	−.03	78.6	−1.3	91	1	86	64	30	71	20	72	71	84	4.04	−2.4	.14	11.1	ne.	29	e.	7	9	14	7	5.5	.0	.0
East Gulf States							**74.4**	**−1.5**										**73**	**2.56**	**−1.8**										**4.1**		
Atlanta [1]	1,173	5	72	28.82	30.03	−.02	71.6	−.8	95	22	83	44	27	60	31	62	58	72	3.07	----	4	7.2	ne.	31	nw.	10	17	9	4	3.3	.0	.0
Macon [3]	370	79	87	29.63	30.01	−.02	73.2	−1.6	97	10	85	48	12	61	35	63	59	71	.92	−2.3	5	5.7	n.	22	nw.	10	15	10	5	4.0	.0	.0
Thomasville	273	49	58	29.72	30.01	.00	74.0	−2.8	95	11	84	48	27	64	33	----	----	----	1.19	−3.7	3	----	----	----	----	----	----	----	----	----	----	----
Apalachicola	35	11	51	29.93	29.97	----	75.7	−2.8	92	1	83	52	27	69	22	69	67	80	5.67	−2.4	8	9.6	ne.	37	se.	18	8	9	13	5.9	.0	.0
Pensacola	56	54	79	29.93	29.99	.00	76.2	−1.8	95	10	84	53	12	68	25	68	64	71	.98	−4.4	4	7.5	e.	20	s.	24	16	6	8	4.2	.0	.0
Anniston	741	9	----	29.28	30.07	+.04	71.2	−.1	93	22	83	44	12	60	31	----	----	----	.64	----	2	----	se.	----	----	----	17	10	3	----	.0	.0
Birmingham [3]	700	11	48	29.30	30.04	+.01	74.2	−.6	95	9	86	46	27	62	30	61	56	68	1.39	−2.0	4	5.5	e.	30	s.	24	18	8	4	3.4	.0	.0
Mobile [3]	57	86	161	29.94	30.00	.00	75.9	−2.2	94	10	86	53	12	66	32	66	64	78	4.86	−.1	5	9.5	n.	26	s.	24	17	8	5	3.8	.0	.0
Montgomery [3]	218	92	105	29.79	30.02	.00	75.6	−.7	97	3	86	48	27	65	29	64	59	70	.29	−2.7	3	6.4	e.	21	nw.	10	15	5	10	4.5	.0	.0
Meridian [3]	375	67	92	29.63	30.02	.00	73.4	−1.1	95	9	86	45	13	61	35	63	59	75	1.65	−1.3	2	4.7	ne.	21	ne.	24	16	7	7	3.6	.0	.0
Vicksburg	247	82	102	29.76	30.02	.00	74.4	−1.9	94	4	85	46	26	64	27	64	60	69	.64	−2.2	3	7.2	n.	27	n.	2	19	4	7	3.1	.0	.0
New Orleans [3]	53	76	84	29.93	29.99	+.01	77.9	−1.3	94	10	85	58	27	71	23	69	66	73	7.99	+3.0	7	7.5	ne.	21	n.	25	15	12	3	3.6	.0	.0
Port Eads, La	9	4	35	29.95	29.96	----	78.5	----	93	2	83	65	13	74	17	----	----	----	6.72	----	10	12.9	e.	32	----	19	----	----	----	5.4	.0	.0
West Gulf States							**75.9**	**−1.2**										**70**	**2.52**	**−1.2**										**3.5**		
Shreveport [3]	249	92	227	29.77	30.03	+.03	74.7	−2.2	95	9	86	47	27	64	28	65	62	76	.36	−2.4	5	8.3	ne.	32	ne.	2	24	2	4	2.6	.0	.0
Bentonville	1,303	12	51	----	----	----	68.7	−.2	92	1	80	36	26	57	35	----	----	----	4.00	+.3	6	4.7	s.	20	s.	2	14	9	7	----	.0	.0
Fort Smith	463	57	82	29.60	30.08	+.07	72.4	−1.6	95	8	83	45	27	62	33	63	58	65	2.82	−.2	5	5.6	e.	26	w.	2	16	5	9	4.7	.0	.0
Little Rock [3]	357	94	102	29.68	30.06	+.03	72.6	−1.5	96	9	83	47	26	62	28	63	60	77	2.17	−1.0	4	6.3	e.	20	ne.	25	15	6	9	4.5	.0	.0
Austin [3]	605	68	90	29.37	29.99	----	76.7	−1.6	100	10	88	49	27	65	35	65	59	64	3.39	.0	3	6.4	ne.	27	nw.	24	21	6	3	2.7	.0	.0
Brownsville [3]	57	88	96	29.88	29.94	----	80.3	−.3	99	24	89	56	27	72	28	71	68	77	1.58	−3.9	4	8.6	e.	23	nw.	26	9	17	4	4.9	.0	.0
Corpus Christi [3]	20	11	78	29.94	29.96	+.01	80.4	+.7	93	9	87	59	27	74	18	71	68	78	3.14	−1.4	7	10.1	e.	28	ne.	6	17	9	4	3.2	.0	.0
Dallas [1]	512	220	227	29.48	30.01	----	75.6	----	99	9	88	45	27	64	34	64	58	61	.22	−2.5	3	8.3	se.	26	n.	10	18	7	5	3.3	.0	.0
Fort Worth [1]	679	35	56	29.32	30.02	+.03	76.6	−.3	100	1	88	47	26	65	31	63	56	58	.08	−1.8	2	9.1	se.	27	nw.	25	16	8	6	3.6	.0	.0
Galveston [3]	54	106	114	29.92	29.98	.00	77.7	−2.4	92	8	82	56	26	73	17	69	66	73	6.87	+1.3	5	9.3	e.	25	n.	25	18	9	3	3.1	.0	.0
Houston [3]	138	157	190	29.84	29.99	----	77.6	−1.4	99	10	88	52	27	67	27	67	63	74	2.49	−1.6	5	9.4	ne.	27	ne.	20	17	9	4	3.5	.0	.0
Palestine	510	64	72	29.50	30.03	+.04	74.2	−2.8	95	1	84	49	27	64	27	64	59	67	1.76	−1.2	4	6.1	ne.	16	e.	20	19	7	4	3.0	.0	.0
Port Arthur	34	59	134	29.96	29.99	----	76.2	----	94	2	85	52	26	68	23	68	65	73	4.32	−.5	6	11.6	ne.	39	ne.	20	18	8	4	3.4	.0	.0
San Antonio [3]	693	111	301	29.26	29.98	+.02	79.0	.0	101	10	90	53	27	68	31	67	62	64	1.42	−1.6	5	9.8	e.	40	n.	24	16	11	3	3.5	.0	.0

See footnotes at end of table.

CLIMATOLOGICAL DATA FOR WEATHER BUREAU STATIONS—Continued

District and station	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01 inch, or more	Wind: Average hourly velocity	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
Ohio Valley and Tennessee	*Ft.*	*Ft.*	*Ft.*	*In.*	*In.*	*In.*	*°F.*	*°F.*	*°F.*		*°F.*	*°F.*		*°F.*	*° F.*	*° F.*	*° F.*	*%*	*In.*	*In.*		*Miles*								*0–10*	*In.*	*In.*
							66.6	−2.1										73	1.53	−1.4											3.6		
Chattanooga [1]	762	71	214	29.25	30.05	−0.01	68.8	−3.4	96	22	84	38	27	54	38	60	57	79	0.49	−2.6	2	4.7	n.	25	ne.	25	16	8	6	3.9	0.0	0.0
Knoxville [2]	995	66	84	29.02	30.06	.00	69.6	−1.0	94	22	82	43	28	57	31	59	54	71	1.17	−1.5	3	4.6	ne.	18	n.	25	24	3	3	1.9	.0	.0
Memphis [2]	399	78	86	29.63	30.04	+.01	73.8	+.2	95	22	83	48	26	64	23	61	58	73	1.88	−.9	1	6.0	e.	21	n.	25	16	7	7	3.8	.0	.0
Nashville [2]	546	167	187	29.48	30.06	.00	71.0	−.8	95	9	83	44	12	59	33	59	54	67	.87	−2.6	4	6.9	ne.	31	n.	25	19	8	3	2.9	.0	.0
Lexington	969	6	.....	29.05	30.11	+.04	66.6	−1.9	97	21	81	38	26	52	36	.....	.....	.....	2.59	−.5	4	.....	.....	.....	.....	.....	24	4	2	1.8	.0	.0
Louisville [2]	525	166	120	29.52	30.08	+.02	68.2	−2.3	95	21	80	41	26	57	31	56	52	70	.97	−1.8	3	6.6	ne.	27	ne.	25	20	8	2	2.5	.0	.0
Evansville [1]	431	76	116	29.62	30.07	+.01	67.0	−3.7	95	21	81	40	27	52	38	57	52	67	.91	−2.4	3	6.0	n.	27	ne.	25	21	6	3	2.8	.0	.0
Indianapolis [2]	823	98	129	29.22	30.10	+.04	66.8	−.1	94	20	78	38	26	56	30	56	51	64	.96	−2.7	3	7.1	ne.	27	ne.	8	19	8	3	3.4	.0	.0
Terre Haute	575	68	149	29.48	30.09	.....	67.5	.....	97	20	79	39	26	56	32	57	52	76	1.23	−1.4	3	5.3	ne.	22	n.	25	14	8	8	4.2	.0	.0
Cincinnati [1]	627	11	51	29.42	30.09	+.02	65.8	−1.3	97	21	78	37	26	53	39	56	51	75	1.55	−1.0	4	6.7	n.	25	sw.	14	9	15	6	4.7	.0	.0
Columbus [2]	822	90	110	29.22	30.09	+.02	64.8	−1.7	94	20	76	37	26	54	34	55	51	71	1.13	−.8	3	6.9	ne.	26	sw.	8	12	11	7	4.5	.0	.0
Dayton	900	186	213	29.15	30.11	.....	64.1	−2.5	93	20	75	35	26	53	35	55	51	80	3.42	+.3	7	4.1	w.	17	nw.	25	15	6	9	5.2	.0	.0
Elkins [2]	1,947	61	78	28.08	30.12	+.04	59.4	−3.6	85	21	72	31	26	47	40	52	50	89	2.13	−.6	5	4.5	n.	18	nw.	25	19	6	5	3.2	.0	.0
Parkersburg	637	77	84	29.41	30.09	+.01	63.8	−3.5	90	20	75	36	26	52	33	57	54	80	2.13	−.6	5	7.9	nw.	34	sw.	24	6	13	11	5.8	.0	.0
Pittsburgh [1]	842	39	54	29.19	30.09	+.01	62.5	−3.9	90	21	73	36	27	52	31	55	51	74	2.59	.0	7	7.9	nw.	34	sw.	24	6	13	11	5.8	.0	.0
Lower Lake Region																															
							61.6	−1.3										82	2.35	−0.6										5.5		
Buffalo [2]	768	243	279	29.24	30.07	+.01	61.0	−1.4	77	18	67	40	26	55	22	54	52	83	3.72	+.8	11	11.4	sw.	36	sw.	10	8	11	11	5.8	.0	.0
Canton	448	10	61	29.55	30.02	.....	58.8	−.5	78	19	70	30	26	48	31	53	50	80	3.49	+.1	9	6.4	w.	24	sw.	10	6	13	11	6.0	.0	.0
Ithaca	836	77	100	29.15	30.06	.....	59.6	−2.0	87	20	71	34	27	48	33	.....	.....	.....	2.79	−.3	11	6.5	nw.	23	nw.	25	6	12	12	6.3	.0	.0
Oswego	335	71	85	29.68	30.05	−.01	59.5	−1.7	82	20	67	41	27	52	25	56	53	81	2.38	−.3	9	7.6	w.	24	n.	24	13	8	9	4.9	.0	.0
Rochester [2]	523	86	102	29.50	30.06	.00	61.6	−.8	85	20	69	43	25	54	24	54	52	85	2.33	−.1	10	7.1	sw.	18	w.	10	10	12	8	5.3	.0	.0
Syracuse [2]	596	65	79	29.41	30.05	−.02	60.0	−1.8	85	20	71	35	26	49	33	54	52	84	1.91	−.8	7	7.9	sw.	26	w.	10	5	12	13	6.7	.0	.0
Erie [2]	714	57	81	29.31	30.09	+.03	61.8	−1.8	80	20	68	42	27	55	21	55	53	87	3.14	−.2	12	6.6	s.	16	e.	15	7	9	14	6.2	.0	.0
Cleveland [2]	762	267	318	29.27	30.09	+.03	63.0	−.9	85	20	69	44	27	57	25	55	52	78	1.83	−1.5	11	12.0	s.	41	ne.	24	10	13	7	5.2	.0	.0
Sandusky	629	5	67	.....	.....	.....	63.8	−1.5	92	20	74	39	27	54	32	.....	.....	.....	3.01	+.1	7	7.0	sw.	22	nw.	10	12	11	7	4.9	.0	.0
Toledo [2]	628	79	87	29.42	30.10	+.04	63.6	−.8	91	20	73	37	26	54	29	55	53	83	1.17	−1.6	5	7.7	w.	24	n.	10	15	10	5	3.9	.0	.0
Fort Wayne [2]	857	69	84	29.19	30.10	.....	63.8	−1.6	92	20	74	38	26	53	29	54	50	75	.70	−2.4	3	6.8	nw.	25	nw.	10	11	9	10	5.1	.0	.0
Detroit [1]	730	5	78	29.31	30.09	+.03	62.8	−.7	91	20	72	36	26	53	27	56	54	79	1.73	−1.2	8	7.6	nw.	23	nw.	10	11	9	10	5.4	.0	.0
Upper Lake Region																															
							60.9	+1.4										82	1.86	−1.5										5.7		
Alpena	609	13	89	29.42	30.08	+.05	59.3	+1.7	89	20	68	36	30	51	28	54	52	84	3.04	+.1	12	9.2	nw.	31	se.	14	7	6	17	6.7	.0	.0
Escanaba	612	51	72	29.43	30.09	+.08	58.6	+1.5	82	7	66	34	26	51	31	54	52	84	1.77	−1.6	9	9.8	s.	35	n.	24	6	12	12	6.6	.0	.0
Grand Rapids [2]	707	70	244	29.33	30.09	+.04	63.2	+.5	88	20	73	38	26	54	29	54	52	83	.65	−2.9	6	8.3	sw.	27	s.	13	11	11	8	5.0	.0	.0
Lansing	878	5	90	29.15	30.10	.....	60.4	−1.0	85	20	69	34	26	52	26	.....	.....	84	1.42	−1.5	6	6.6	nw.	21	nw.	10	12	10	8	5.0	.0	.0
Marquette	734	44	73	29.27	30.08	+.08	59.7	+2.2	87	6	67	38	25	52	26	54	52	81	3.05	−.2	10	7.7	w.	23	s.	23	7	9	14	6.5	.0	.0
Sault Ste. Marie [2]	614	11	52	29.40	30.08	+.06	57.8	+2.3	82	20	66	35	25	50	31	52	50	89	1.99	−2.2	12	6.6	nw.	24	nw.	24	3	9	18	7.5	T	.0
Chicago	673	7	131	29.39	30.11	+.07	64.6	−.6	90	20	72	42	26	57	26	57	54	75	.31	−2.8	3	8.7	ne.	30	ne.	24	11	14	5	4.5	.0	.0
Green Bay	617	109	141	29.42	30.09	+.07	62.0	+1.6	85	20	71	37	25	53	26	56	53	78	2.36	−1.2	7	9.4	s.	30	n.	24	9	9	12	5.8	.0	.0
Milwaukee [2]	681	126	221	29.38	30.11	+.08	63.2	+.7	88	20	71	40	25	56	24	56	53	81	.55	−2.7	3	10.5	w.	30	n.	24	13	7	10	4.9	.0	.0
Duluth	1,133	5	47	28.86	30.07	+.09	60.0	+4.9	84	7	70	31	25	50	29	53	50	80	3.47	+.2	5	9.9	ne.	31	nw.	10	12	10	8	4.9	.0	.0
North Dakota																															
							63.2	+6.0										66	0.94	−0.6										3.6		
Moorehead, Minn. [2]	940	50	58	29.03	30.04	+.08	63.8	+5.6	92	19	76	30	25	51	49	55	49	69	.22	−2.0	6	7.7	s.	21	n.	9	17	9	4	3.3	.0	.0
Bismarck [1]	1,677	4	41	28.26	30.03	+.09	64.4	+6.3	98	3	81	27	11	48	46	54	48	64	1.38	+.2	4	10.2	e.	34	se.	4	16	10	4	3.9	.0	.0
Devils Lake	1,478	11	44	28.48	30.05	+.11	61.0	+5.1	89	5	75	29	25	48	36	53	49	74	1.16	−.5	9	7.5	se.	25	n.	9	13	9	8	4.3	.0	.0
Lemmon, S. Dak.	2,602	4	38	27.32	30.01	.....	64.6	.....	94	3	79	32	11	50	43	53	45	.....	.77	.....	4	.....	.....	.....	.....	.....	.....	.....	.....	.....	.0	.0
Grand Forks	832	12	67	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Williston	1,878	42	50	28.04	29.99	+.06	63.8	+7.2	100	3	77	30	10	50	44	53	45	59	1.02	−.1	5	6.1	se.	24	se.	2	20	7	3	3.0	.0	.0
Upper Mississippi Valley																															
							66.8	+1.5										70	0.92	−2.7										3.7		
Minneapolis, St. Paul, Minn. [1]	919	32	61	29.08	30.06	+.07	65.3	+3.9	91	19	76	36	26	54	36	57	52	71	.41	−2.7	5	9.4	s.	28	nw.	9	14	10	6	4.0	.0	.0
Springfield, Minn.	1,025	4	42	28.97	30.06	.....	66.0	.....	91	19	76	36	26	54	36	57	52	.....	.94	.....	5	.....	.....	.....	.....	.....	.....	.....	.....	.....	.0	.0
La Crosse [2]	714	11	48	29.32	30.09	+.08	64.0	+1.8	93	7	78	34	25	54	33	57	52	77	.29	−3.7	7	6.4	s.	19	nw.	20	12	10	8	4.8	.0	.0
Madison [2]	974	70	78	29.07	30.12	+.09	62.9	+.5	87	20	74	37	26	54	29	56	52	78	.84	−2.9	6	6.5	s.	26	ne.	24	8	16	6	5.0	.0	.0
Charles City	1,015	10	51	29.02	30.11	+.11	63.6	+2.6	87	20	72	40	26	54	28	55	52	76	2.63	−1.0	7	5.1	se.	17	se.	17	19	8	3	2.8	.0	.0
Davenport [2]	606	66	161	29.45	30.12	+.09	67.2	+1.6	88	7	75	36	25	52	32	56	53	74	1.69	−1.9	5	5.1	se.	17	se.	17	19	8	3	2.8	.0	.0
Des Moines [2]	860	5	99	29.16	30.08	+.06	67.6	+2.0	93	21	78	40	25	56	28	56	53	67	.35	−3.3	2	7.7	sw.	24	ne.	24	18	6	6	3.7	.0	.0
Dubuque	699	60	79	29.36	30.10	+.07	64.9	+.9	92	21	79	36	26	56	32	58	52	72	1.48	−2.5	2	8.0	se.	24	n.	24	17	9	4	3.4	.0	.0
Keokuk	614	64	78	29.44	30.09	+.06	68.0	+.5	91	20	76	36	26	54	31	57	53	64	.04	−3.8	7	4.7	s.	15	n.	9	14	7	9	4.6	.0	.0
Cairo	358	87	93	29.69	30.07	+.02	70.9	−.6	93	21	80	41	26	57	31	58	52	64	1.75	−1.1	1	5.4	sw.	19	sw.	13	20	4	6	3.0	.0	.0
Peoria [2]	609	11	45	29.45	30.11	+.07	66.6	+2.3	94	22	82	45	27	60	31	60	55	73	1.16	−2.9	2	5.8	ne.	28	n.	24	16	7	7	3.9	.0	.0
Springfield, Ill. [2]	636	5	191	29.42	30.10	+.05	68.8	+1.2	94	20	79	34	26	54	36	56	52	68	.38	−3.3	3	3.9	ne.	14	ne.	25	21	5	4	2.4	.0	.0
St. Louis [2]	568	179	303	29.49	30.09	+.05	71.8	+1.3	95	21	81	40	27	57	30	55	50	53	.03	−3.4	2	9.3	s.	25	n.	24	16	8	6	3.9	.0	.0
Missouri Valley							69.1	+2.8	95	20	82	44	26	61	29	59	51	68	1.28	−1.9	1	8.2	ne.	24	nw.	9	20	6	4	3.0	.0	.0
							69.1	+2.8										68	1.28	−1.9										4.5		
Columbia, Mo. [2]	784	6	66	29.26	30.10	+.07	70.0	+1.1	95	20	82	39	11	57	38	59	54	68	1.30	−3.3	4	5.7	e.	19	nw.	10	17	8	5	3.5	.0	.0
Kansas City [1]	963	8	76	29.06	30.07	+.05	69.6	+1.2	94	8	81	37	26	59	35	61	56	80	.78	−3.1	4	8.0	sw.	28	nw.	9	10	12	8	4.7	.0	.0
St. Joseph [2]	967	11	49	29.21	30.08	.....	67.8	−1.1	93	21	80	37	26	59	33	60	56	75	2.42	−1.1	8	7.0	s.	20	n.	9	16	10	4	3.5	.0	.0
Springfield, Mo. [1]	1,324	5	78	28.70	30.10	+.07	70.2	+1.5	90	9	79	36	12	56	36	60	56	68	1.20	−2.6	4	8.1	se.	30	n.	24	16	4	10	4.5	.0	.0
Topeka	987	65	87	29.03	30.07	.....	70.6	+4.2	98	8	81	38	26	59	35	61	56	64	1.74	−1.2	8	7.8	s.	23	n.	9	8	11	11	5.7	.0	.0
Lincoln [2]	1,189	11	81	28.80	30.04	+.05	69.0	+2.2	100	8	83	38	11	58	41	58	52	66	.56	−2.6	4	9.1	s.	25	n.	9	12	13	5	4.2	.0	.0
Omaha [1]	1,105	31	44	29.03	30.06	+.06	68.6	+6.1	95	7	81	38	26	57	36	59	54	62	1.22	−.1	4	9.3	se.	30	sw.	25	8	14	9	4.4	.0	.0
Valentine	2,598	46	54	27.32	30.00	+.04	68.0	+4.6	100	7	82	30	11	55	44	57	50	69	2.77	−.3	7	8.7	s.	30	sw.	18	8	11	11	5.5	.0	.0
Sioux City [2]	1,138	64	106	28.85	30.05	+.07	68.0	+6.7	94	7	79	35	12	56	45	58	54	60	.52	−1.0	4	8.8	s.	29	sw.	7	10	12	8	4.7	.0	.0
Huron [1]	1,301	26	41	28.64	30.02	+.06	63.0	+6.2	98	2	82	29	25	54	53	56	49	61	1.81	+0.6	6	13.5	s.	40	sw.	15	11	14	5	4.5	.0	.0
Northern Slope																															
							63.0	+6.2										61	1.81	+0.6										5.6		
Billings [1]	3,570	18	39	26.34	29.94	.....	66.2	.....	98	2	78	44	30	54	40	53	43	51	1.09	.....	8	8.9	sw.	40	nw.	4	7	14	9	5.5	.0	.0
Havre	2,507	11	67	27.37	29.98	+.04	64.2	+7.8	98	2	78	40	25	50	45	52	44	55	1.47	+.2	6	7.8	e.	26	sw.	4	17	10	3	3.2	.0	.0
Helena [1]	4,124	85	111	25.84	29.99	+.02	60.4	+3.8	90	1	73	37	30	48	43	51	45	63	2.00	+.8	14	6.9	sw.	43	sw.	13	2	13	15	7.2	.0	.0
Missoula [2]	3,263	80	91	26.64	29.98	.....	63.1	+7.7	91	7	76	39	6	51	42	54	48	67	1.68	+.2	12	6.3	e.	31	se.	7	4	17	9	6.3	.0	.0
Kalispell	2,973	48	56	26.95	29.96	.00	60.8	+7.3	86	11	72	40	6	50	35	54	48	68	1.69	+.4	11	5.1	w.	21	sw.	13	8	7	15	6.3	.0	.0
Miles City [2]	2,371	48	55	27.50	29.96	+.01	68.6	+7.4	98	2	81	40	10	56	39	55	45	50	.51	−.5	5	5.8	ne.	20	se.	3	11	13	6	4.6	.0	.0
Rapid City [2]	3,259	50	58	26.68	29.99	+.03	66.6	+6.2	95	1	79	39	11	54	39	55	46	57	1.27	+.1	8	6.5	w.	20	n.	8	13	8	9	4.5	.0	.0
Cheyenne [1]	6,094	5	39	24.11	29.99	+.03	60.1	+3.1	91	1	72	38	11	48	41	51	46	70	3.75	+2.6	18	8.3	s.	35	se.	3	7	8	19	7.2	.0	.0
Lander	5,352	60	68	24.71	29.94	−.02	61.8	+6.1	91	1	75	40	27	48	39	51	43	58	1.73	+.8	9	5.0	sw.	25	w.	4	5	18	7	5.5	.0	.0
Sheridan [1]	3,790	10	47	26.14	29.96	.....	64.6	.....	100	2	80	40	11	50	47	52	44	56	2.05	+.8	7	4.0	s.	22	se.	3	11	5	11	5.7	.0	.0
Yellowstone Park	6,241	12	46	23.98	30.08	+.11	55.2	+5.1	83	2	67	32	30	43	35	46	41	68	2.84	+1.6	15	6.7	sw.	29	sw.	7	3	12	12	6.7	.0	.0
North Platte [2]	2,821	11	51	27.11	29.99	+.02	69.2	+7.1	98	8	82	39	11	57	38	58	52	68	.88	−.5	6	7.1	s.	25	sw.	18	11	14	7	5.0	.0	.0

See footnotes at end of table.

CLIMATOLOGICAL DATA FOR WEATHER BUREAU STATIONS—Continued

District and station	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01 inch, or more	Wind: Average hourly velocity	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F.		°F.	°F.		°F.	°F.	°F.	°F.	%	In.	In.		Miles								0–10	In.	In.
Middle Slope							69.5	+1.4										67	2.69	+0.6										5.2		
Denver [2]	5,292	106	113	24.82	29.98	+0.02	65.2	+2.3	91	1	75	50	30	56	29	55	50	70	2.47	+1.5	12	6.2	s.	29	ne.	5	9	13	8	5.3	0.0	0.0
Pueblo [1]	4,690	79	86	25.35	29.96	.00	66.7	+2.1	94	1	80	45	26	53	42	55	49	65	1.96	+1.2	9	7.0	e.	27	s.	18	6	14	10	5.8	.0	.0
Concordia	1,392	50	58	28.60	30.05	+.06	70.4	+2.1	95	17	81	40	11	60	34	61	56	66	.83	−1.8	5	7.9	s.	21	se.	3	9	13	8	5.1	.0	.0
Dodge City	2,509	10	86	27.44	30.00	+.02	70.2	+.8	97	17	82	44	25	59	38	60	54	66	2.05	+.2	8	11.0	s.	29	s.	5	12	10	8	5.0	.0	.0
Wichita [2]	1,358	85	93	28.63	30.05	+.05	71.0	+.4	95	2	81	44	26	61	31	61	57	71	6.14	+3.0	9	9.7	se.	28	se.	2	15	6	9	4.6	.0	.0
Oklahoma City [2]	1,214	10	47	28.78	30.04	+.05	73.6	+.8	99	1	84	44	26	63	31	62	56	64	2.71	−.3	7	8.1	s.	20	n.	10	11	9	10	5.3	.0	.0
Chadron, Nebr.	3,439	5	44	26.51	29.97	.....	69.2	.....	102	1	82	38	10	56	39	56	48	...	1.34	.....	10	.....	.....	.....	.....	.....	.....	.....	.....	.....	.0	.0
Southern Slope							74.9	+1.4										56	0.56	−2.0										4.0		
Abilene [2]	1,738	10	56	28.22	29.99	+.03	76.6	+1.3	97	9	88	46	26	65	30	63	56	60	.97	−1.7	7	9.0	se.	22	n.	24	20	3	7	3.7	.0	.0
Amarillo [2]	3,676	10	49	26.33	29.98	+.02	72.2	+2.9	96	13	84	47	26	60	35	58	51	58	.54	−1.8	4	10.3	se.	25	se.	30	14	12	4	4.4	.0	.0
Del Rio	960	63	71	28.98	29.94	.00	78.0	−1.2	98	24	88	55	27	68	29	66	59	57	.18	−2.8	1	8.0	se.	29	n.	6	15	11	4	3.8	.0	.0
Roswell	3,566	75	85	26.41	29.95	+.03	72.8	+2.5	94	16	86	51	27	60	39	58	49	50	.57	−1.5	5	7.2	s.	25	nw.	4	14	11	5	4.0	.0	.0
Southern Plateau							72.1	+1.7										57	1.07	+0.2										4.1		
El Paso [2]	3,778	82	101	26.19	29.88	.00	77.2	+3.3	95	13	89	58	19	66	32	60	50	45	.25	−1.0	6	7.7	e.	27	nw.	30	14	15	1	3.8	.0	.0
Albuquerque [1]	4,972	5	34	25.13	29.94	.....	68.4	+.5	89	9	80	51	30	56	32	57	51	62	1.99	+1.2	13	7.3	se.	32	se.	20	9	13	8	5.1	.0	.0
Santa Fe	7,013	38	53	23.79	30.00	+.07	62.5	+1.6	83	9	73	45	23	52	30	52	46	64	2.55	+1.1	8	5.4	e.	21	n.	30	5	14	11	6.2	.0	.0
Flagstaff	6,907	10	59	23.43	29.89	.00	57.6	+2.1	78	9	70	37	21	45	33	50	45	71	3.65	.....	15	7.5	nw.	25	sw.	16	3	21	6	5.9	.0	.0
Phoenix [2]	1,107	39	87	28.68	29.80	−.01	85.2	+2.5	107	9	98	67	21	73	32	67	58	48	1.43	+.7	5	5.3	e.	26	sw.	6	16	9	5	4.1	.0	.0
Yuma	142	9	54	29.65	29.79	+.01	85.3	+1.6	109	10	99	64	19	72	39	69	60	51	.53	+.2	4	4.1	s.	25	e.	7	24	4	2	1.8	.0	.0
Independence	3,957	5	26	25.92	29.89	+.02	68.2	+.2	90	10	83	43	29	54	38	50	33	...	T	−.1	0	5.3	s.	.....	.....	.....	.....	.....	.....	1.2	.0	.0
Middle Plateau							63.3	+1.2										56	1.81	+1.1										4.6		
Reno [2]	4,527	61	76	25.44	29.93	−.02	60.2	−.3	86	11	74	34	19	46	38	48	39	57	.56	+.3	5	5.8	w.	30	nw.	3	15	7	8	3.9	.0	.0
Tonopah	6,090	12	20	24.04	29.90	.....	61.2	.....	80	8	72	38	19	50	29	46	33	...	.60	.....	2	.....	se.	.....	.....	.....	.....	.....	.....	2.0	.0	.0
Winnemucca	4,344	18	56	25.58	29.92	−.01	61.0	+1.8	92	1	77	34	29	45	43	49	38	52	1.53	+1.1	12	7.6	ne.	25	s.	11	8	15	7	4.9	.0	.0
Modena	5,473	10	46	.....	29.92	.00	60.4	+.4	85	1	74	37	28	47	37	.....	.....	...	2.88	+2.1	12	9.3	w.	38	nw.	27	9	11	10	5.2	.0	.0
Salt Lake City [2]	4,357	86	210	25.62	29.93	−.02	66.8	+2.4	93	1	78	41	27	56	41	54	47	57	1.72	+.7	12	7.6	se.	32	s.	17	7	13	10	5.7	.0	.0
Grand Junction	4,602	60	68	25.42	29.96	+.01	67.9	+1.7	95	1	79	48	30	57	30	56	48	57	2.35	+1.4	15	6.1	se.	23	w.	28	7	12	11	5.9	.0	.0
Northern Plateau							64.6	+4.6										66	2.20	+1.4										5.7		
Baker [2]	3,471	36	54	26.43	29.97	−.02	59.4	+3.4	89	11	72	38	21	47	41	51	46	73	3.90	+3.2	15	5.1	s.	19	s.	9	7	11	12	5.7	.0	.0
Boise [1]	2,739	5	49	27.13	29.93	−.04	63.2	.....	93	11	74	38	28	52	34	55	49	66	1.87	.....	11	8.9	se.	37	w.	7	4	11	15	6.6	.0	.0
Pocatello [1]	4,478	5	31	25.50	29.97	+.01	60.4	.....	90	1	73	32	30	48	42	51	46	67	3.80	.....	15	7.0	sw.	30	s.	17	6	8	16	6.4	.0	.0
Spokane [2]	1,929	101	110	27.93	29.94	−.04	64.6	+5.4	92	11	75	47	6	54	34	56	51	69	2.12	+1.2	7	5.5	s.	22	s.	27	9	10	11	5.5	.0	.0
Walla Walla	991	57	65	28.87	29.93	−.07	67.4	+3.6	91	8	77	50	29	57	33	.....	.....	...	1.96	+1.0	9	4.9	s.	23	w.	26	7	12	11	5.9	.0	.0
Yakima	1,076	58	67	28.79	29.93	.....	67.1	+6.0	95	9	80	47	5	55	33	56	48	54	.83	+.3	5	5.8	nw.	35	sw.	9	16	8	6	3.9	.0	.0
North Pacific Coast Region							62.7	+3.7										78	2.69	+0.5										6.6		
North Head	211	5	56	29.77	29.99	−.04	60.2	+3.7	82	22	65	50	19	56	25	58	56	91	2.90	−.1	15	10.6	n.	29	s.	17	8	8	14	6.6	.0	.0
Seattle [2]	125	90	321	29.84	29.97	−.04	64.0	+5.9	85	22	72	49	19	56	29	58	54	78	2.58	+.8	9	6.4	n.	26	sw.	17	8	7	15	6.1	.0	.0
Tacoma	194	172	201	29.78	29.98	−.04	62.5	+5.2	80	22	70	45	20	55	26	.....	.....	...	2.21	+.1	7	5.9	n.	27	w.	17	5	7	18	7.1	.0	.0
Tatoosh Island	86	9	61	29.89	29.98	−.03	57.6	+4.6	66	8	62	47	6	53	14	56	54	88	2.41	−2.3	10	9.4	e.	37	s.	9	6	9	15	6.7	.0	.0
Medford [1]	1,329	29	58	28.55	29.94	.....	64.0	+.7	91	8	77	45	20	51	45	55	48	66	2.31	+1.8	11	.....	nw.	.....	.....	.....	7	10	13	6.0	.0	.0
Portland, Oreg. [3]	154	68	106	29.79	29.96	−.07	65.6	+3.9	88	23	74	46	19	58	28	60	55	74	3.56	+1.6	9	5.2	nw.	15	sw.	17	5	7	18	7.1	.0	.0
Roseburg	510	45	76	29.41	29.96	−.06	65.0	+2.1	90	22	76	42	20	54	39	57	53	72	2.83	+1.6	11	4.0	nw.	20	sw.	7	5	7	18	6.7	.0	.0
Middle Pacific Coast Region							66.1	+1.2										66	0.51	−0.2										4.6		
Eureka	60	72	88	29.92	29.99	−.02	59.8	+3.9	73	6	65	49	19	54	21	56	54	85	.91	−.1	5	5.7	sw.	26	n.	29	5	9	16	6.3	.0	.0
Redding [1]	722	20	34	29.14	29.90	.....	70.2	−3.3	90	22	81	49	27	60	28	56	45	45	.53	−.3	4	7.8	nw.	34	w.	26	10	13	7	4.9	.0	.0
Sacramento [3]	66	92	115	29.83	29.90	+.01	69.4	+.1	89	21	82	51	27	57	34	58	50	56	.01	−.4	1	6.9	sw.	18	s.	26	23	3	4	2.1	.0	.0
San Francisco	155	112	132	29.77	29.94	.00	65.0	+4.1	83	29	71	55	4	59	24	59	56	80	.59	+.1	6	7.8	w.	29	w.	18	9	10	11	5.0	.0	.0
South Pacific Coast Region							69.9	+0.1										66	0.03	−0.1										2.9		
Fresno [1]	327	89	98	29.54	29.89	+.02	71.3	−2.1	94	1	86	46	29	56	37	59	49	52	.00	−.2	0	6.8	nw.	26	nw.	27	22	5	3	2.3	.0	.0
Los Angeles	338	223	250	29.55	29.91	+.03	69.6	+.6	90	26	80	54	30	60	28	61	56	69	.01	−.2	1	5.9	w.	20	w.	17	21	8	1	2.3	.0	.0
San Diego [1]	87	62	70	29.81	29.90	+.01	68.7	+1.6	93	26	76	57	6	62	28	63	60	78	.08	.0	3	6.9	w.	17	nw.	10	16	10	4	4.2	.0	.0
West Indies																																
San Juan, P. R.	82	10	54	29.83	29.91	.....	81.8	+1.3	92	13	87	74	24	76	15	.....	.....	...	1.49	−4.4	11	8.3	e.	26	ne.	25	1	20	9	6.3	.0	.0
Panama Canal																																
Balboa Heights	118	6	92	.....	[3]29.81	−.01	80.4	+.6	90	12	86	73	5	75	15	.....	.....	[3]86	13.99	+5.7	23	4.4	nw.	18	se.	9	0	18	12	7.3	.0	.0
Cristobal	36	6	97	.....	[3]29.81	−.02	82.0	+1.6	89	11	87	75	29	77	13	76	75	[3]84	13.77	+1.2	20	5.7	se.	20	ne.	29	0	5	25	8.5	.0	.0
Alaska																																
Fairbanks	454	11	87	.....	[4]29.74	.....	45.7	+2.3	77	7	55	17	27	36	.....	.....	.....	70	.75	−.5	10	6.2	e.	20	sw.	24	2	6	22	.....	T	.0
Juneau	80	96	116	[4]29.83	[4]29.92	.....	52.2	+2.0	67	7	57	40	30	48	22	50	47	82	9.31	.....	23	7.6	s.	31	e.	21	6	1	23	8.0	.0	.0
Nome	22	5	59	.....	[4]29.62	.....	43.3	+1.7	55	7	49	24	25	37	.....	.....	.....	79	3.72	+1.0	20	12.6	n.	34	s.	20	1	5	24	.....	T	.0
Hawaiian Islands																																
Honolulu	38	86	100	29.91	29.95	.....	79.0	+.8	85	23	84	71	23	74	14	71	68	71	.53	−.8	13	8.9	e.	25	e.	1	10	12	8	5.1	.0	.0

[1] Data are airport records.
[2] Barometric and hygrometric data from airport, other data city office records.
[3] Observations taken bihourly.
[4] Pressure not reduced to a mean of 24 hours.
[5] Barometric, hygrometric, and temperature records from airport, other data from city office records.
[6] Wind, and clear, partly cloudy, and cloudy data, from city office records, other data from airport records.

NOTE.—Except as indicated by notes 1, 2, 5, and 6, data in table are city office records.

SEVERE LOCAL STORMS

[Compiled by MARY O. SOUDER from reports submitted by Weather Bureau officials]

[The table herewith contains such data as has been received concerning severe local storms that occurred during the month. A revised list of tornadoes will appear in the United States Meteorological Yearbook]

Place	Date	Time	Width of path, yards	Loss of life	Value of property destroyed	Character of storm	Remarks
Fort Worth, Tex.	1	6-7 p. m.			$25,000	Straight-line-wind.	Buildings and electric service damaged; 2 persons injured.
New Jersey, southwestern quarter of the State.	1			4	1,000,000	Tropical disturbance.	Rainfall measured from 4.50 to 10.52 inches, within 12 hours at most stations. Number of small rivers flooded, breaking several dams. Property damage, mostly to highways and bridges, is estimated at more than $1,000,000. It is remarkable, however, that no rain fell at the coastal stations of New Jersey from this storm.
Niagara County, N. Y., northern portion.	1		[1] 2-3		205,000	Heavy hail.	Property damage, $5,000; crops loss, $200,000; path 30 miles long.
Haysville, Kans., vicinity of.	2	6 p. m.		0		Tornado.	This storm struck for a short distance in a wheat field.
Kit Carson, Colo.	3	3 p. m.			5,000	Heavy rain.	Highway washed out; houses flooded.
Montezuma to Cimarron, Kans.	5	3:40-5 p. m.	[1] 1-6		4,000	do.	Loss mostly in feed crops; path 20 miles long.
Denver, Colo.	5	6 p. m.			500	Hail and wind.	Damage to greenhouses, $500; severe loss to crops and gardens. Denver covered with from 2 to 4 inches of hail about the size of marbles.
Moccasin, Ariz.	6				5,000	Heavy rain and wind.	Fields and houses flooded; crops buried more than a foot under the sand.
Brunsville to Oyens, Iowa.	7	11 p. m.	[1] 2-4		5,100	Hail, electrical.	About 250 farms affected; greatest damage to late corn. Many windows broken; house damaged by lightning; loss in crops, $15,000.
Stanton, Nebr., vicinity of.	7				4,000	Thunderstorm.	3 barns burned.
Cheesman, Colo.	9	1 p. m.	[1] 1		500	Heavy hail.	Property damaged; loss to crops, $500. Ground covered with 4 inches of hail.
Hoehne, Colo.	9	P. m.	[1] 6		100,000	do.	Loss in beets and other crops.
Kiowa, Colo.	9	do.			1,000	Hail.	Loss to crops.
Lockport, N. Y.	15				10,000	Thunderstorm.	Barn and contents destroyed by lightning.
Arvada, Colo.	20	5 p. m.				Hail.	Heavy loss in flowers, hay, and tomatoes.
Houston, Tex.[2]	21	do.			3,000	Thundersquall.	Damage confined to a narrow mile-long east-and-west strip a few blocks south of the business section; property damaged.
Albuquerque, N. Mex., vicinity of.	21				1,000	Electrical.	Barn and contents destroyed.
New Roads and False River Section, La.	24	4:45 a. m.		1	6,000	Tornado.	Several small homes destroyed and several damaged including a cotton gin and the New Roads Livestock Exchange Bldg. Several persons injured, 1 critically.
Chunky, Miss., vicinity of.	24		100	0	3,000	do.	The first damage occurred about a mile northwest of Chunky when a residence was moved 10 to 12 feet from its foundation with the only person in the house a woman, who was slightly injured when she was blown from the back porch into an adjoining room. A short distance away, a Negro church was blown from its foundation and several tenant houses unroofed. Trees blown down lay in all directions, showing the effect of the rotary motion of the storm. A funnel cloud was not observed, but many persons mentioned the red appearance of the clouds prior to the occurrence of the tornado and all reported the roaring noise similar to the passing of a heavy freight train. Large timbers, pieces of roofing, and other debris seen whirling in the air several hundred feet high. Several persons slightly injured; path 880 yards long.
Lauderdale, Miss.	24		500	1	30,000	do.	At least 9 houses completely demolished and 30 others badly damaged; several persons were injured requiring hospital treatment. About 256 persons cared for by the Red Cross. Trees uprooted and broken lay in all directions. Small casualty list because the storm struck during daylight hours rather than at night. Path 3 miles long.
Chicago, Ill.,[2] and vicinity.	25	P. m.			250,000	Wind.	For 18 hours high waves battered the harbors of Jackson, Grant and Burnham Parks; 16 small boats capsized and 36 others were damaged.
Atlantic City, N. J.,[2] vicinity of.	25	do.		1		Wind and rain.	Loss in crops; damage to electric and telephone lines and property.
Aztec Ruins, N. Mex.	30	4:45-5:05 p. m.	[1] 1		3,500	Heavy hail.	Property damage, $1,500; crop loss, $2,000.

LATE REPORTS FOR AUGUST 1940[3]

Gridley, Kans., 5 miles south and 2 miles west.	14	P. m.		0	$6,000	Tornado.	Chief damage to buildings on 2 farms.
Eula, Tex.	17	5 a. m.	100	0	500	do.	Damage to barns and outbuildings.
Munday to Goree, Tex.	27	5-6 p. m.	[1] 2		55,000	Heavy hail.	Crop loss, $50,000; property damage, $5,000.
Gatesville, Tex.	29	3-3:15 p. m.	[1] 3		15,000	do.	Crop loss, $10,000; property damage, $5,000.
Paducah, Tex.	29	3-4 p. m.	[1] 3-5		15,000	do.	Loss to crops.
Marlin, Tex.	29	3:20-3:55 p.m.	[1] 10		5,000	Hail and wind.	Damage to property and utilities.

[1] Miles instead of yards.
[2] From press reports.
[3] 6-9: Supplementary report on tropical storm of August 1940, in Louisiana. This storm was tabulated on August 6-7, with $200,000 damage. Later reports gave August 6-9, with estimated damage of $6,445,000 in Louisiana where 37.50 inches of rain fell in 4 days. A detailed account appears in "*Daily and Hourly Precipitation, Supplement No. 1, Precipitation in Louisiana and Adjacent Areas, Storm of August 6-10, 1940*," issued by the Hydrological Unit of the Weather Bureau at Fort Worth, Tex.

SOLAR RADIATION AND SUNSPOT DATA FOR SEPTEMBER 1940

A PREDICTION OF MONTHLY SUNSPOT NUMBERS THROUGH 1944

By JOHN Q. STEWART and FORREST C. EGGLESTON
[Princeton University, Princeton, New Jersey, October 1940]

In several recent papers [1] a method has been outlined for fitting the curve

$$R = F(r-s)^a e^{-b(r-s)}$$

to sunspot numbers, where R is the Wolf number at time r, and F, a, b are constants throughout a given cycle or outburst. *Annual* numbers for the remainder of the present cycle were predicted by extrapolating such a fit.[2] More recently we have published our predicted *monthly* numbers,[3] together with annual numbers predicted by others.

In Tables 1 and 2 our predictions are here reprinted to

[1] J. Q. Stewart and H. A. A. Panofsky, *Ap. J. 88*, 385, 1938. J. Q. Stewart and F. C. Eggleston, *Ap. J. 91*, 72, 1940. *Cf.* M. Waldmeier, *Astronom. Mitteil.* (Zurich) *133*, 105, 1935.

[2] J. Q. Stewart and F. C. Eggleston, *Physical Review 55*, 102, 1939.
[3] J. Q. Stewart and F. C. Eggleston, *Publ. A. S. P.* in press (Dec. 1940).

bring them to the attention of meteorologists. Our method cannot predict the course of sunspots after the beginning of the next cycle, which may be expected (but uncertainly) in 1944. We question whether any method can at the present time predict in detail spot numbers after the next "outburst" begins.

TABLE 1.—*Annual Wolf numbers 1933–44*

Year	Observed	Computed	Year	Observed	Computed
1933.5	5.7	(7)	1939.5	88.8	87
1934.5	8.7	(7)	1940.5		61
1935.5	36.1	(37)	1941.5		38
1936.5	79.7	(84)	1942.5		22
1937.5	114.1	(111)	1943.5		12
1938.5	109.6	(109)	1944.5		6

NOTE.—The computed numbers in parentheses, 1933–38, were those used in the fit the computed numbers after January 1, 1939, were predictions by extrapolation.

TABLE 2.—*Predicted monthly numbers 1939–44*

	1939	1940	1941	1942	1943	1944
January	99.8	73.5	48.2	28.9	16.2	8.6
February	97.8	71.1	46.2	27.5	15.3	8.1
March	95.8	68.9	44.4	26.3	14.6	7.7
April	93.8	66.8	42.8	25.2	13.9	7.3
May	91.4	64.4	40.9	23.9	13.1	6.8
June	89.4	62.3	39.3	22.8	12.5	6.5
July	87.2	60.3	37.7	21.8	11.9	6.2
August	84.8	58.0	36.0	20.7	11.2	5.8
September	82.6	56.0	34.5	19.8	10.7	5.5
October	80.4	54.1	33.1	18.9	10.1	5.2
November	77.9	51.9	31.6	17.9	9.6	4.9
December	75.7	50.1	30.2	17.0	9.1	4.6

NOTE.—All the computed monthly values are for the middle of the month. A random irregularity from the predictions, month by month, is to be expected: The predictions purport to represent the underlying trend.

POSITIONS, AREAS, AND COUNTS OF SUNSPOTS

[Communicated by Capt. J. F. Hellweg, U. S. Navy (Ret.), Superintendent, U. S. Naval Observatory.] All measurements and spot counts were made at the Naval Observatory from plates taken at the observatories indicated. Difference in longitude is measured from the central meridian, positive toward the west. Latitude is positive toward the north. Areas are corrected for foreshortening and expressed in millionths of Sun's hemisphere. For each day, under longitude, latitude, area of spot or group, and spot count, are included assumed longitude of center of the disk, assumed latitude of center of the disk, total area of spots and groups, and total spot count.

Date	Eastern standard time	Mount Wilson group No.	Heliographic: Difference in longitude	Heliographic: Longitude	Heliographic: Latitude	Heliographic: Distance from center of disk	Area of spot or group	Spot count	Plate quality	Observatory
1940	h m		°	°	°	°				
Sept. 1	11 4	6973	−74	115	−4	75	24	5	F	U. S. Naval.
		6972	−69	120	−17	73	145	10		
		6971	−48	141	−11	52	48	11		
		6969	−48	141	+12	48	12	2		
		6969	−40	149	+11	40	291	14		
		6968	−38	151	+16	39	145	1		
		6967	−10	179	+15	13	73	6		
		6967	−2	187	+15	8	73	7		
		6965	+6	195	−7	15	776	35		
		6955	+87	276	−7	88	48	1		
				(189)	(+7)		1,490	92		
Sept. 2	11 25	6972	−55	120	−17	60	194	15	G	Do.
		6971	−34	141	−11	39	121	8		
		6969	−27	148	+10	27	194	10		
		6968	−24	151	+16	26	145	1		
		6967	+3	178	+15	9	48	2		
		6967	+12	187	+15	14	48	2		
		6965	+17	192	−8	23	291	35		
		6965	+26	201	−8	31	582	8		
		6974	+60	235	−7	63	73	7		
				(175)	(+7)		1,696	88		

POSITIONS, AREAS, AND COUNTS OF SUNSPOTS—Con.

Date	Eastern standard time	Mount Wilson group No.	Heliographic: Difference in longitude	Heliographic: Longitude	Heliographic: Latitude	Heliographic: Distance from center of disk	Area of spot or group	Spot count	Plate quality	Observatory
1940	h m		°	°	°	°				
Sept. 3	10 56	6972	−41	121	−17	47	194	15	VG	U. S. Naval.
		6971	−20	142	−11	26	133	10		
		6969	−20	142	+12	21	48	6		
		6969	−13	149	+11	14	145	2		
		6968	−11	151	+16	15	48	1		
		6967	+17	179	+15	20	36	3		
		6967	+26	188	+15	27	24	3		
		6965	+30	192	−7	34	291	35		
		6965	+39	201	−8	42	582	4		
		6974	+73	235	−7	75	12	3		
				(162)	(+7)		1,513	82		
Sept. 4	11 18	6972	−28	121	−17	38	194	11	G	Do.
		6971	−5	144	−10	18	145	14		
		6969	+2	151	+11	5	121	3		
		6968	+3	152	+16	10	145	1		
		6967	+30	179	+15	31	24	1		
		6965	+44	193	−7	46	194	15		
		6965	+52	201	−7	55	485	48		
				(149)	(+7)		1,308	93		
Sept. 5	10 57	6972	−14	122	−17	29	218	18	Gn	Do.
		6972	−7	129	−15	24	48	4		
		6971	+3	139	−10	17	48	3		
		6971	+10	146	−10	20	97	11		
		6969	+11	147	+12	13	24	8		
		6969	+15	151	+11	16	121	10		
		6968	+16	152	+16	19	145	2		
		6975	+46	182	−11	48	73	6		
		6965	+57	193	−7	60	97	10		
		6965	+67	203	−7	69	485	1		
				(136)	(+7)		1,356	73		
Sept. 6	10 50	6977	−78	45	+16	77	6	1	G	Do.
		6977	−69	54	+14	70	6	1		
		6972	−1	122	−17	24	267	19		
		6971	+23	146	−10	29	145	16		
		6969	+29	152	+10	29	73	6		
		6968	+30	153	+16	32	121	2		
		6975	+57	180	−10	60	12	2		
		6975	+60	183	−12	63	97	7		
		6965	+80	203	−7	80	582	1		
				(123)	(+7)		1,309	55		
Sept. 7	10 48	6977	−56	54	+16	56	73	8	G	Do.
		6978	−1	109	−13	20	12	1		
		6972	+11	121	−18	27	158	9		
		6972	+17	127	−17	30	48	18		
		6971	+36	146	−10	40	145	24		
		6969	+41	151	+11	41	48	6		
		6968	+43	153	+16	43	97	2		
		6975	+76	186	−12	77	48	4		
				(110)	(+7)		629	72		
Sept. 8	9 4	6977	−49	48	+15	49	73	14	G	Mount Wilson.
		6972	+26	123	−17	35	242	30		
		6971	+47	144	−12	50	97	23		
		6969	+53	150	+11	53	24	4		
		6968	+56	153	+16	56	73	9		
				(97)	(+7)		509	80		
Sept. 9	11 27	6979	−88	355	+6	88	48	2	G	U. S. Naval.
		6977	−38	45	+14	39	24	10		
		6977	−32	51	+14	33	24	6		
		*	+31	114	+5	31	6	1		
		6972	+40	123	−17	47	170	15		
		6971	+62	145	−12	65	97	10		
		6968	+70	153	+16	70	48	2		
				(83)	(+7)		417	46		
Sept. 10	12 21	6979	−74	355	+6	74	242	2	G	Do.
		6977	−18	51	+14	20	145	15		
		*	−11	58	+5	11	6	1		
		6972	+53	122	−17	59	182	9		
		6971	+76	145	−12	78	6	1		
				(69)	(+7)		581	28		
Sept. 11	12 46	6979	−60	356	+6	60	145	3	F	Do.
		6977	−4	52	+14	9	121	10		
		6972	+66	122	−16	70	97	5		
				(56)	(+7)		363	18		

*=Not numbered.
VG=very good; G=good; F=fair; P=poor.

POSITIONS, AREAS, AND COUNTS OF SUNSPOTS—Con.

Date	Eastern standard time	Mount Wilson group No.	Heliographic: Difference in longitude	Heliographic: Longitude	Heliographic: Latitude	Heliographic: Distance from center of disk	Area of spot or group	Spot count	Plate quality	Observatory
1940	h m		°	°	°	°				
Sept. 12	11 42	6980	−57	346	+15	57	48	4	G	U. S. Naval.
		6979	−47	356	+6	47	73	6		
		6977	+9	52	+14	11	97	6		
		6972	+79	122	−16	80	48	1		
				(43)	(+7)		266	17		
Sept. 13	11 32	6980	−43	347	+15	43	48	5	G	Do.
		6979	−34	356	+6	34	24	2		
		6981	−31	359	+14	32	24	4		
		6977	+24	54	+14	25	145	14		
				(30)	(+7)		241	25		
Sept. 14	10 48	6982	−73	304	−13	75	6	1	VG	Do.
		6980	−26	351	+15	28	12	5		
		6979	−21	356	+5	21	12	3		
		6981	−18	359	+14	20	24	4		
		6977	+38	55	+14	39	206	20		
				(17)	(+7)		260	33		
Sept. 15	12 47	6982	−57	306	−13	61	6	1	G	Do.
		6980	−14	349	+15	17	97	11		
		6981	−8	355	+14	12	24	2		
		6983	+17	20	+26	24	73	6		
		6977	+54	57	+15	54	97	9		
				(3)	(+7)		297	29		
Sept. 16	11 19	6985	−80	271	−10	80	121	1	VG	Do.
		6982	−43	308	−12	47	6	2		
		6980	0	351	+14	7	145	15		
		6983	+29	20	+27	34	73	6		
		6984	+37	28	−7	40	24	3		
		6977	+67	58	+15	67	97	9		
				(351)	(+7)		466	36		
Sept. 17	11 40	6985	−72	265	−11	74	121	1	F	Do.
		6985	−67	270	−10	69	170	1		
		6982	−29	308	−12	35	170	14		
		6980	+12	349	+15	15	121	17		
		6986	+20	357	+3	21	6	3		
		6983	+41	18	+27	44	48	7		
		6984	+55	32	−7	58	12	4		
		6977	+78	55	+15	78	12	1		
				(337)	(+7)		660	48		
Sept. 18	11 27	6988	−85	239	−5	85	48	1	F	Do.
		6988	−85	239	−11	86	242	3		
		6987	−67	257	−11	69	48	1		
		6985	−59	265	−11	61	73	1		
		6985	−53	271	−10	56	97	1		
		6982	−15	309	−11	23	364	19		
		6980	+26	350	+15	27	339	22		
		6986	+34	358	+4	35	12	2		
		6983	+52	16	+28	54	36	5		
				(324)	(+7)		1,259	55		
Sept. 19	11 29	6988	−70	241	−7	72	145	3	F	Do.
		6988	−69	242	−11	70	194	6		
		6987	−53	258	−11	55	24	1		
		6985	−45	266	−10	48	73	2		
		6985	−39	272	−10	42	97	1		
		6982	−2	309	−12	20	533	25		
		6980	+40	351	+15	40	436	30		
				(311)	(+7)		1,502	68		
Sept. 20	11 16	6988	−57	241	−7	60	97	3	G	Do.
		6988	−56	242	−11	60	145	5		
		6987	−40	258	−11	44	6	1		
		6985	−31	267	−11	36	73	2		
		6985	−27	271	−10	33	97	1		
		6989	−19	279	+4	20	48	3		
		6982	+12	310	−11	22	727	37		
		6980	+53	351	+16	53	630	32		
				(298)	(+7)		1,823	84		
Sept. 21	11 1	6991	−80	205	−6	81	582	1	VG	Do.
		6988	−43	242	−7	46	73	6		
		6988	−42	243	−10	45	73	10		
		6987	−26	259	−11	32	6	1		
		6985	−18	267	−10	25	24	2		
		6985	−13	272	−9	22	97	1		
		6989	−5	280	+4	5	48	5		
		6990	+17	302	+8	17	24	3		
		6982	+25	310	−11	30	727	35		
		6980	+61	346	+18	61	48	1		
		6980	+67	352	+14	67	533	20		
				(285)	(+7)		2,235	85		

POSITIONS, AREAS, AND COUNTS OF SUNSPOTS—Con.

Date	Eastern standard time	Mount Wilson group No.	Heliographic: Difference in longitude	Heliographic: Longitude	Heliographic: Latitude	Heliographic: Distance from center of disk	Area of spot or group	Spot count	Plate quality	Observatory
1940	h m		°	°	°	°				
Sept. 22	11 39	6991	−66	205	−6	68	582	1	G	U. S. Naval.
		6988	−29	242	−7	33	48	4		
		6988	−28	243	−10	32	48	8		
		6985	−5	265	−10	18	12	7		
		6985	+1	272	−9	16	97	1		
		6992	+15	286	−6	20	6	1		
		6982	+40	311	−10	43	776	30		
		6980	+78	349	+14	78	145	9		
				(271)	(+7)		1,714	61		
Sept. 23	12 2	6991	−52	206	−6	54	533	1	G	Do.
		6995	−43	215	+6	43	12	2		
		6988	−16	242	−7	21	24	6		
		6988	−15	243	−11	24	48	2		
		6985	+14	272	−9	21	97	1		
		6994	+21	279	−5	24	6	1		
		6993	+42	300	+23	44	97	1		
		6982	+48	306	−11	51	194	5		
		6982	+60	318	−10	63	533	1		
				(258)	(+7)		1,544	20		
Sept. 24	11 32	6991	−39	206	−5	41	436	1	G	Do.
		6996	−15	230	+12	16	12	7		
		6988	−1	244	−10	18	24	1		
		6985	+28	273	−8	32	121	1		
		6993	+56	301	+23	58	109	2		
		6982	+61	306	−10	64	194	4		
		6982	+73	318	−9	75	727	1		
				(245)	(+7)		1,623	17		
Sept. 25	15 4	6997	−77	153	−11	79	12	3	G	Do.
		6991	−23	207	−5	26	436	1		
		6996	0	230	+11	4	6	1		
		6988	+12	242	−7	19	24	1		
		6985	+42	272	−8	45	73	1		
		6993	+70	300	+23	70	61	3		
		6982	+78	308	−10	79	73	1		
				(230)	(+7)		685	11		
Sept. 26	12 19	6991	−11	207	−5	16	436	1	F	Do.
		6996	+9	227	+8	10	6	2		
		6988	+23	241	−7	27	12	1		
		6985	+55	273	−8	59	73	1		
				(218)	(+7)		527	5		
Sept. 27	11 24	6991	+2	207	−5	12	436	1	G	Do.
		6999	+8	213	+14	11	12	4		
		6998	+20	225	−9	26	48	5		
		6985	+68	273	−8	70	73	1		
				(205)	(+7)		569	11		
Sept. 28	10 57	6991	+15	207	−5	19	436	1	G	Do.
		6999	+21	213	+14	23	24	2		
		6998	+33	225	−9	37	24	3		
		6985	+81	273	−8	82	73	1		
				(192)	(+7)		557	7		
Sept. 29	11 56	7001	−76	103	+5	76	73	2	VG	Do.
		7000	−23	156	−9	28	12	3		
		7000	−20	159	−5	23	12	2		
		6991	+29	208	−5	31	412	1		
		6998	+48	227	−9	50	121	12		
				(179)	(+7)		630	20		
Sept. 30	9 34	7001	−67	100	+5	67	73	4	VG	Mount Wilson.
		7000	−8	159	−7	17	12	4		
		6991	+41	208	−5	43	412	1		
		6999	+49	216	+14	49	48	12		
		6998	+61	228	−9	63	291	15		
				(167)	(+7)		836	36		

Mean daily area for 30 days = 962.

*=Not numbered.
VG=very good; G=good; F=fair; P=poor.

Chart I. Departure (°F.) of the Mean Temperature from the Normal, and Wind Roses for Selected Stations, September 1940

Chart I. Departure (°F.) of the Mean Temperature from the Normal, and Wind Roses for Selected Stations, September 1940

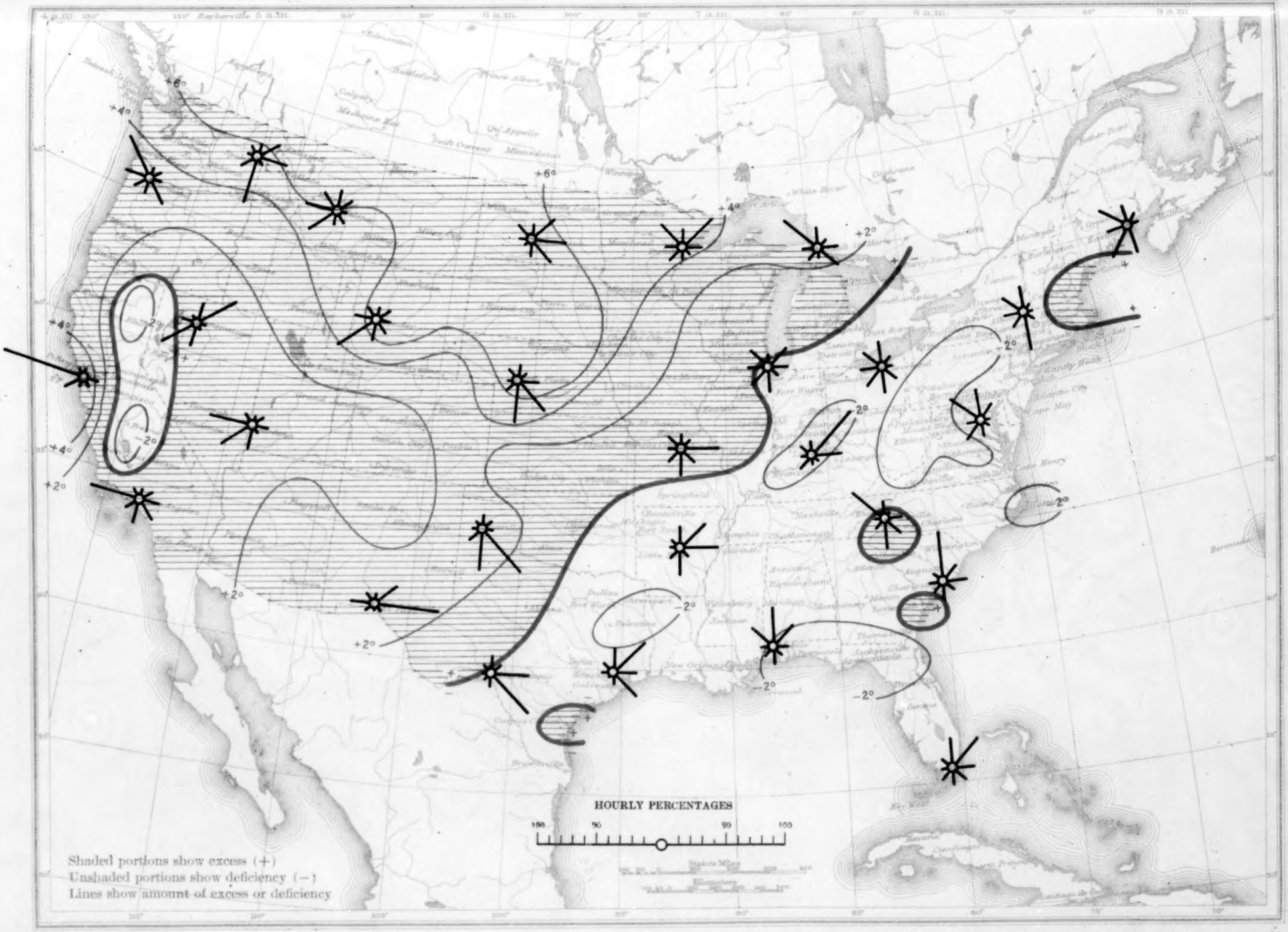
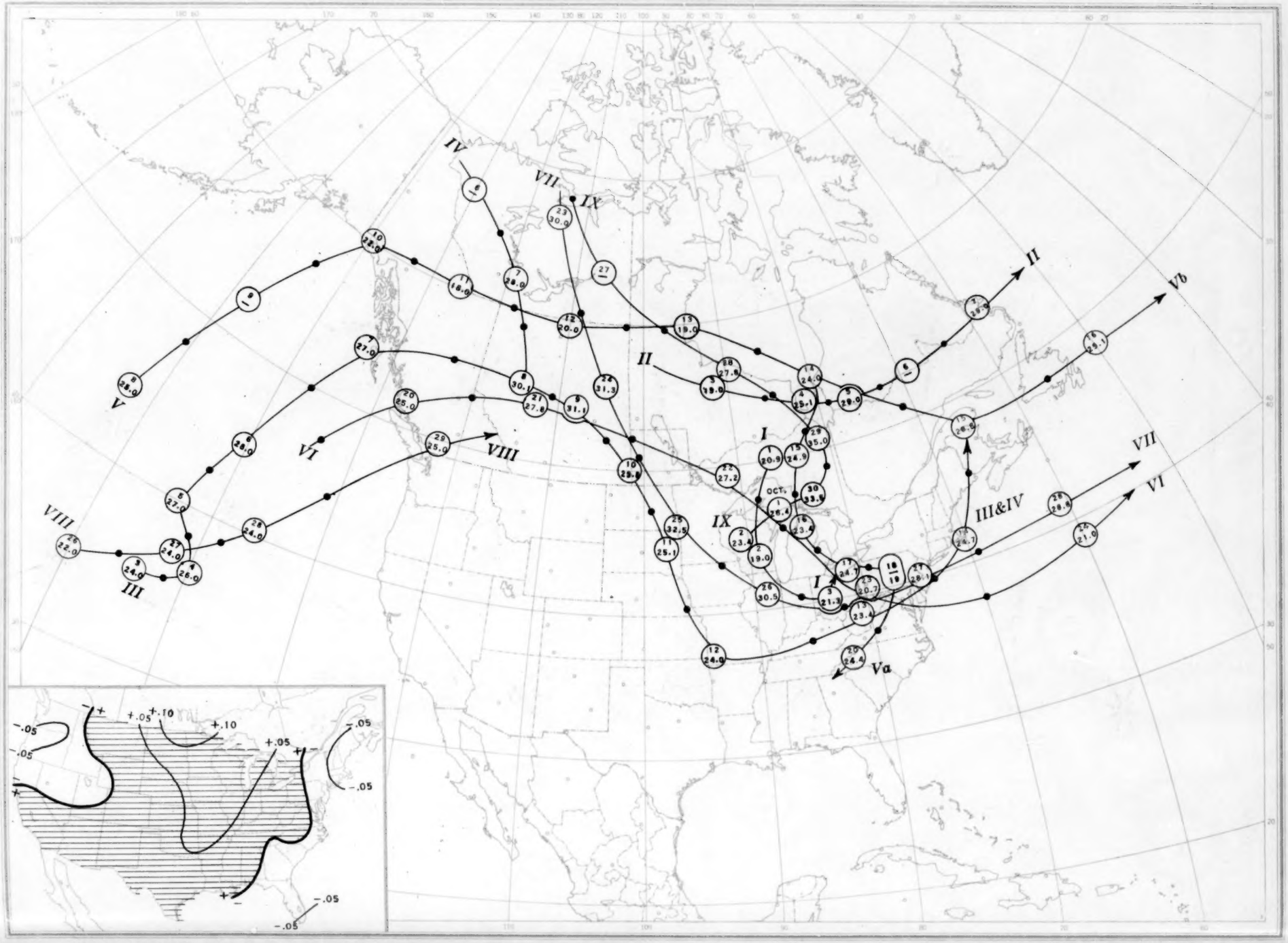


Chart II. Tracks of Centers of Anticyclones, September 1940. (Inset) Departure of Monthly Mean Pressure from Normal

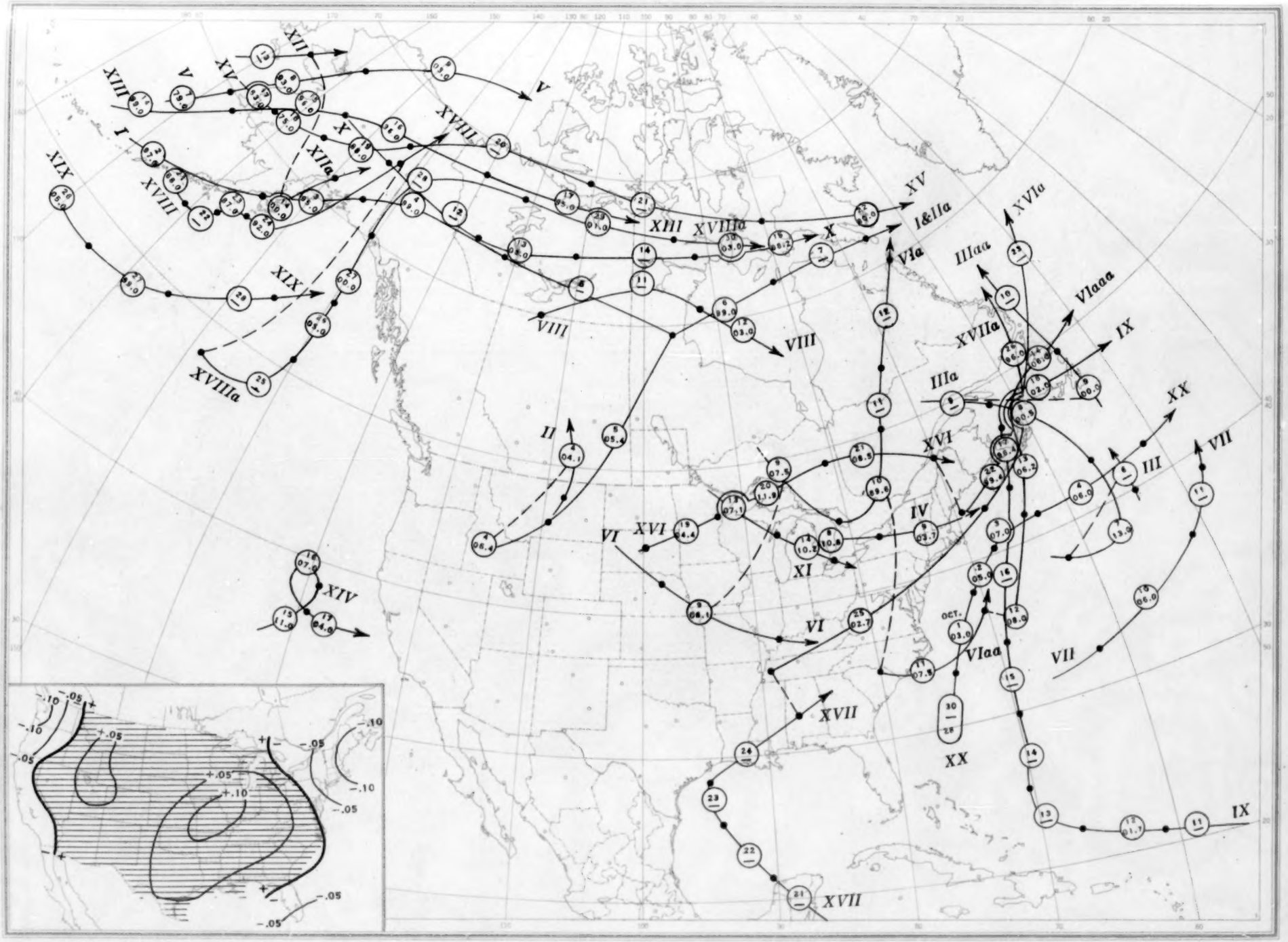


Circle indicates position of anticyclone at 7:30 a. m. (75th meridian time), with barometric reading. Dot indicates position of anticyclone at 7:30 p. m. (75th meridian time).

Chart III. Tracks of Centers of Cyclones, September 1940. (Inset) Change in Mean Pressure from Preceding Month

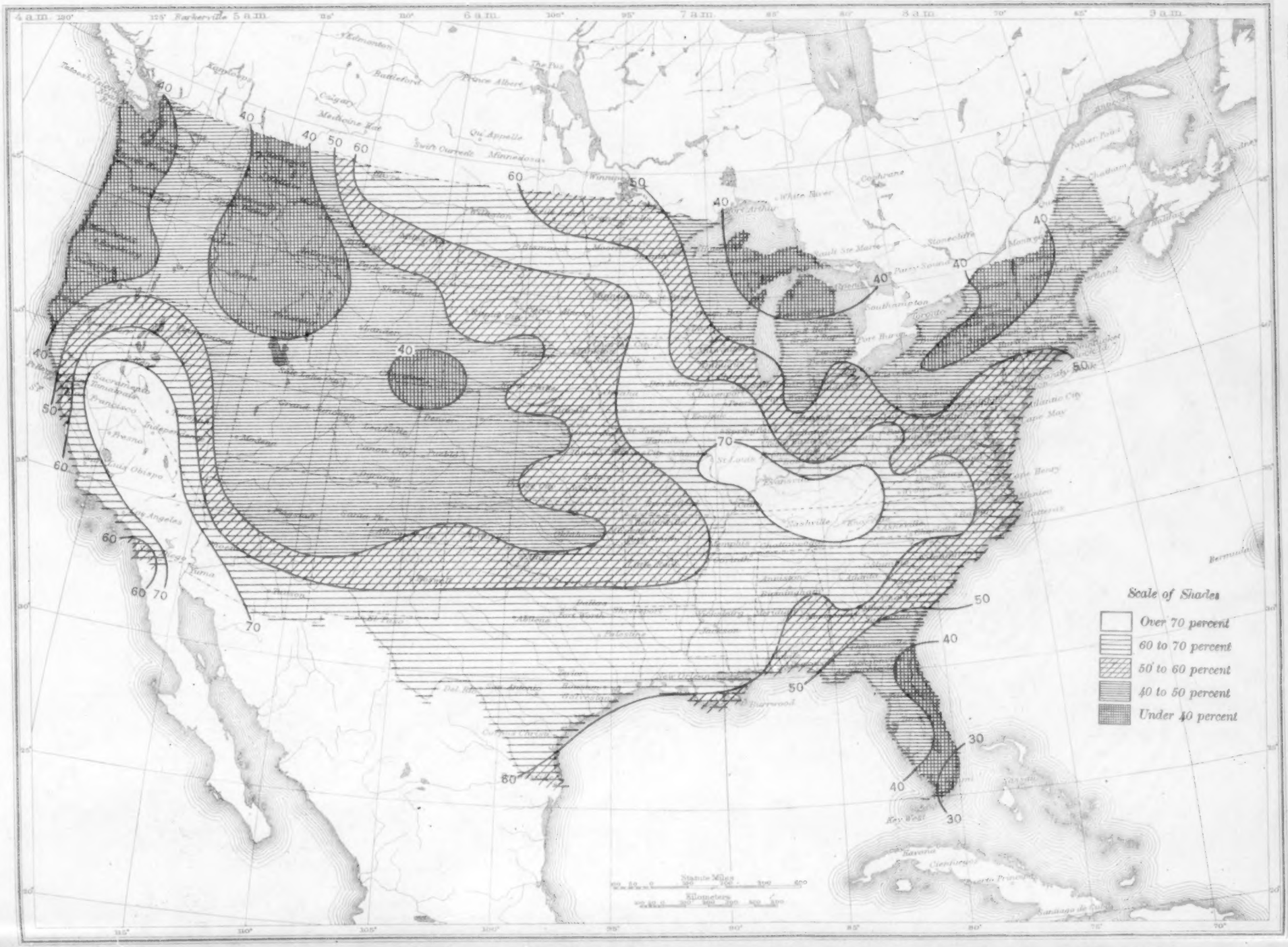
Circle indicates position of anticyclone at 7:30 a. m. (75th meridian time), with barometric reading. Dot indicates position of anticyclone at 7:30 p. m. (75th meridian time).

Chart III. Tracks of Centers of Cyclones, September 1940. (Inset) Change in Mean Pressure from Preceding Month



Circle indicates position of cyclone at 7:30 a. m. (75th meridian time), with barometric reading. Dot indicates position of cyclone at 7:30 p. m. (75th meridian time).

Chart IV. Percentage of Clear Sky Between Sunrise and Sunset, September 1940



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September 1940. M. W. R.

Chart V. Total Precipitation, Inches, September 1940. (Inset) Departure of Precipitation from Normal

Chart V. Total Precipitation, Inches, September 1940. (Inset) Departure of Precipitation from Normal

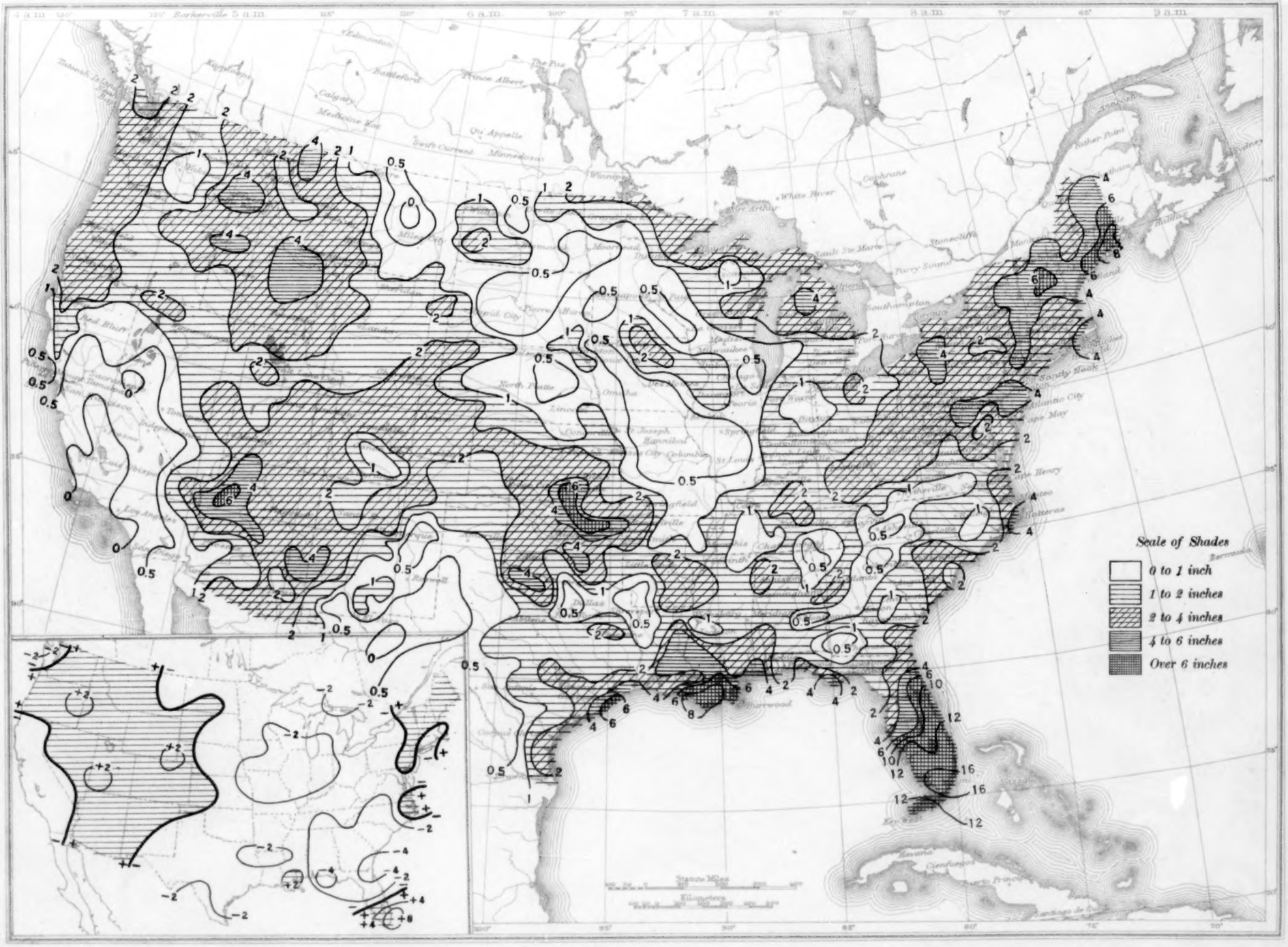


Chart VI. Isobars at Sea Level and Isotherms at Surface; Prevailing Winds, September 1940

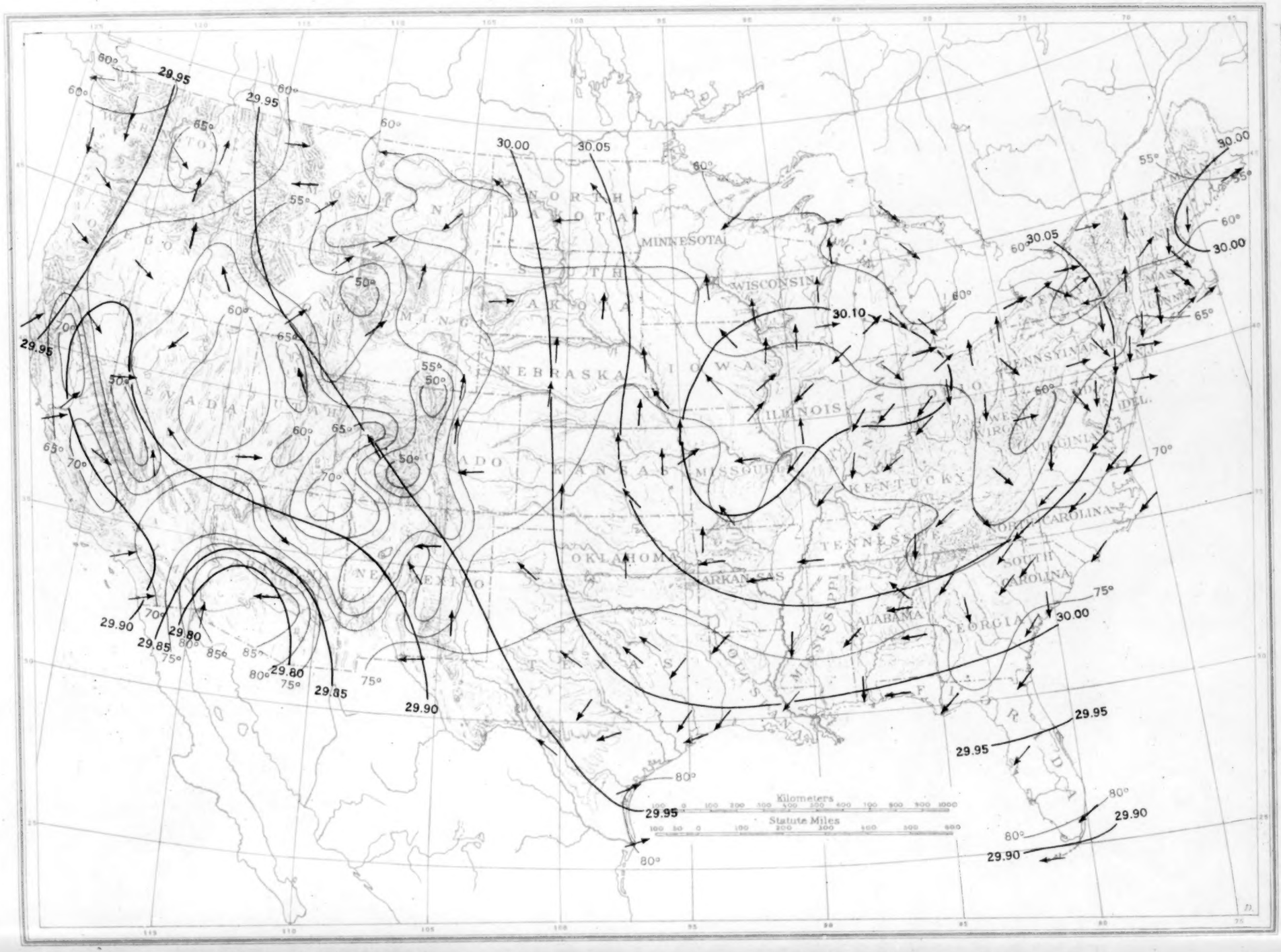


Chart VIII. Isobars (mb) for 1,524 Meters (5,000 ft.) and Isotherms (°C.) and Resultant Winds for 1,500 Meters (m. s. l.) September 1940

Isobars and isotherms based on radiosonde observations at 1:00 a. m. (E. S. T.) and winds based on pilot-balloon observations at 5:00 a. m. (E. S. T.).

Chart VIII. Isobars (mb) for 1,524 Meters (5,000 ft.) and Isotherms (°C.) and Resultant Winds for 1,500 Meters (m. s. l.) September 1940

Isobars and isotherms based on radiosonde observations at 1:00 a. m. (E. S. T.) and winds based on pilot-balloon observations at 5:00 a. m. (E. S. T.).

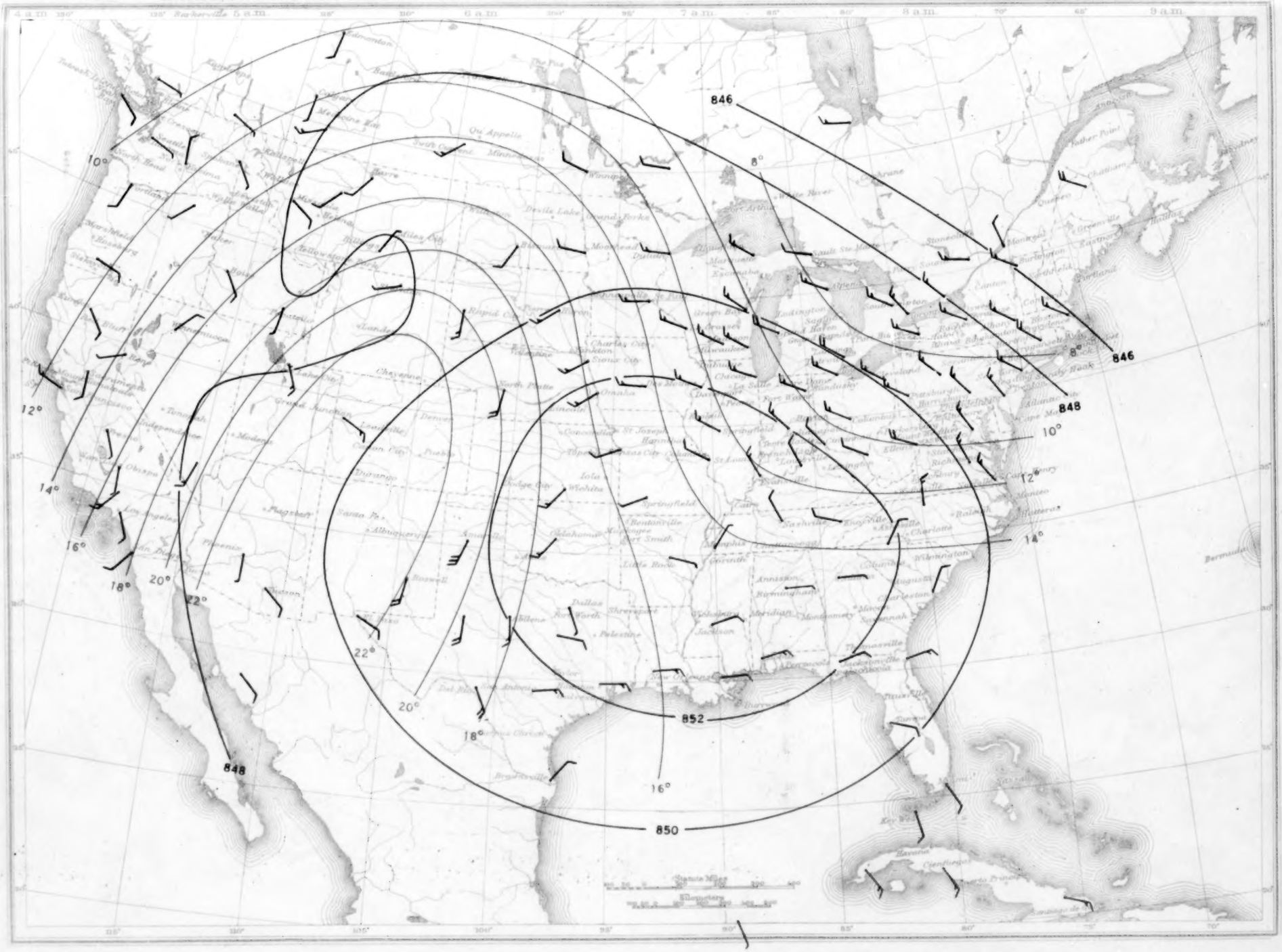


Chart IX. Isobars (mb) Isotherms (°C.) 1:00 a.m. (E.S.T) and Resultant Winds 5:00 a.m. (E.S.T.) for 3,000 Meters (m.s.l.) September 1940

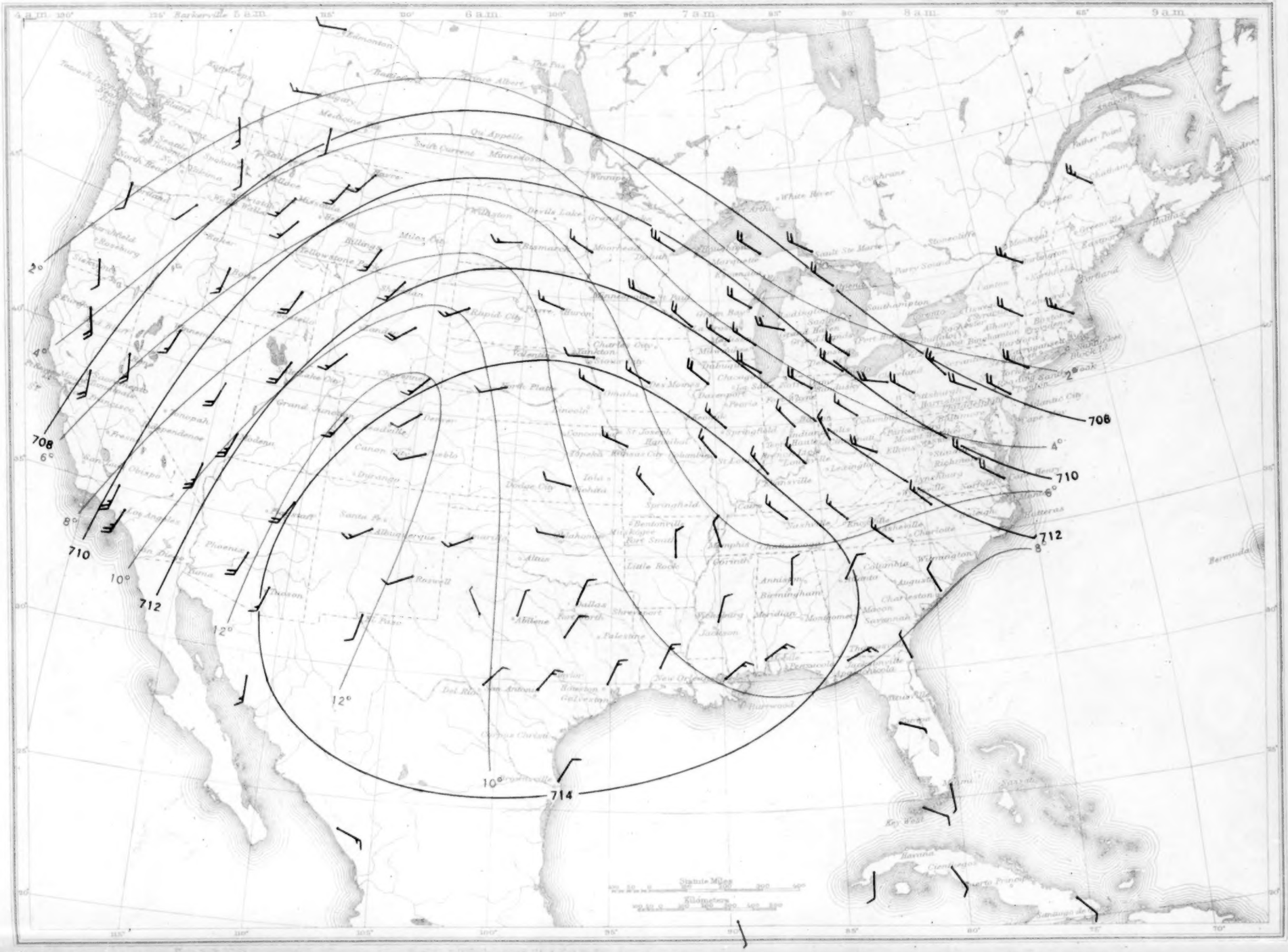


Chart X. Isobars (mb) Isotherms (°C.) 1:00 a.m. (E.S.T.) and Resultant Winds 5:00 p.m. (E.S.T.) for 5,000 Meters (m.s.l.) September 1940

Chart X. Isobars (mb) Isotherms (°C.) 1:00 a.m. (E.S.T.) and Resultant Winds 5:00 p.m. (E.S.T.) for 5,000 Meters (m.s.l.) September 1940

Chart XI. Isobars (mb) Isotherms (°C.) 1:00 a.m. (E.S.T.) and Resultant Winds 5:00 p.m. (E.S.T.) for 10,000 Meters (m.s.l.) September 1940

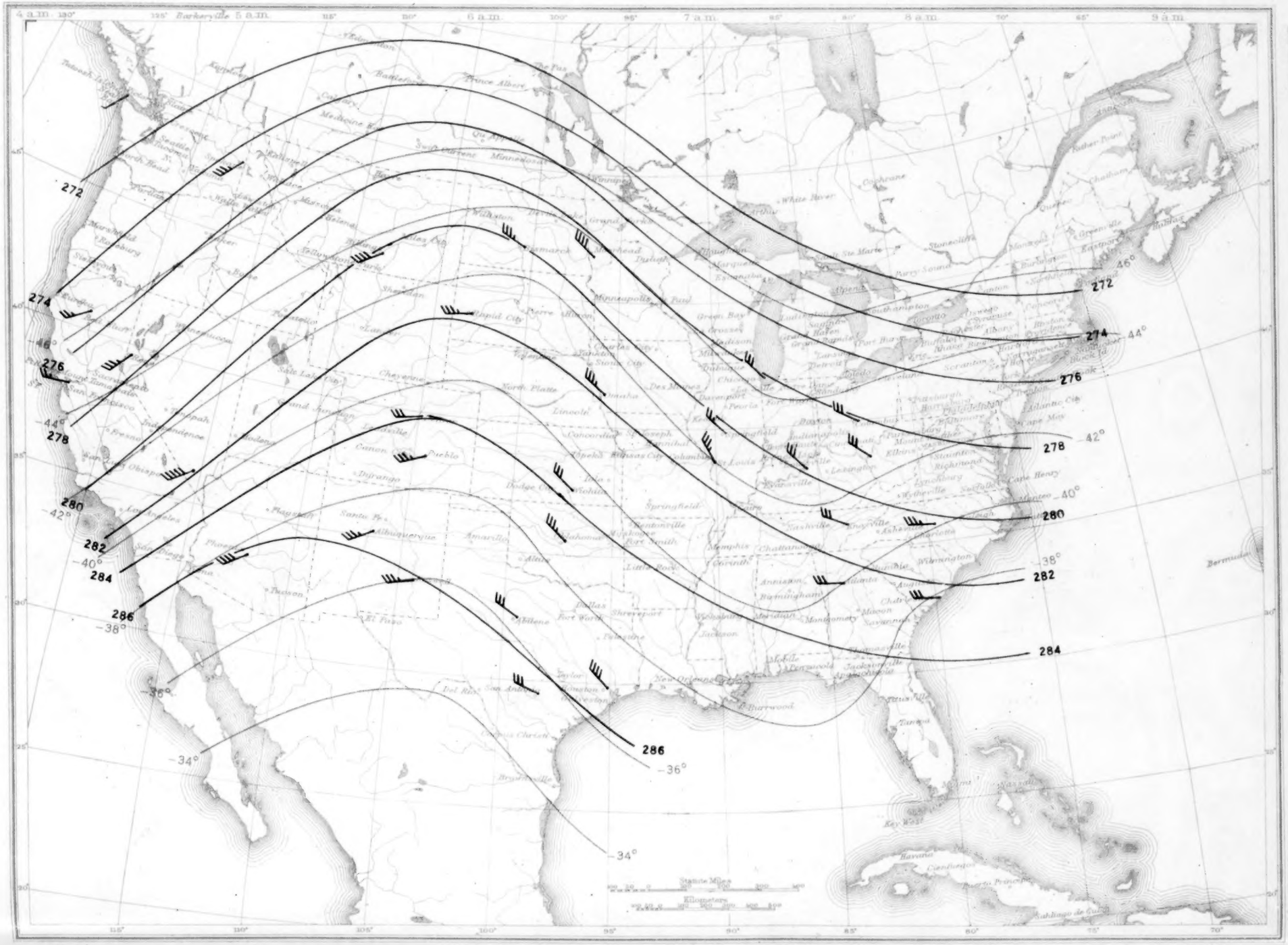


Chart XII. Mean Isentropic Chart, September 1940 (Potential Temperature 310° A.)

Chart XII. Mean Isentropic Chart, September 1940 (Potential Temperature 310° A.)

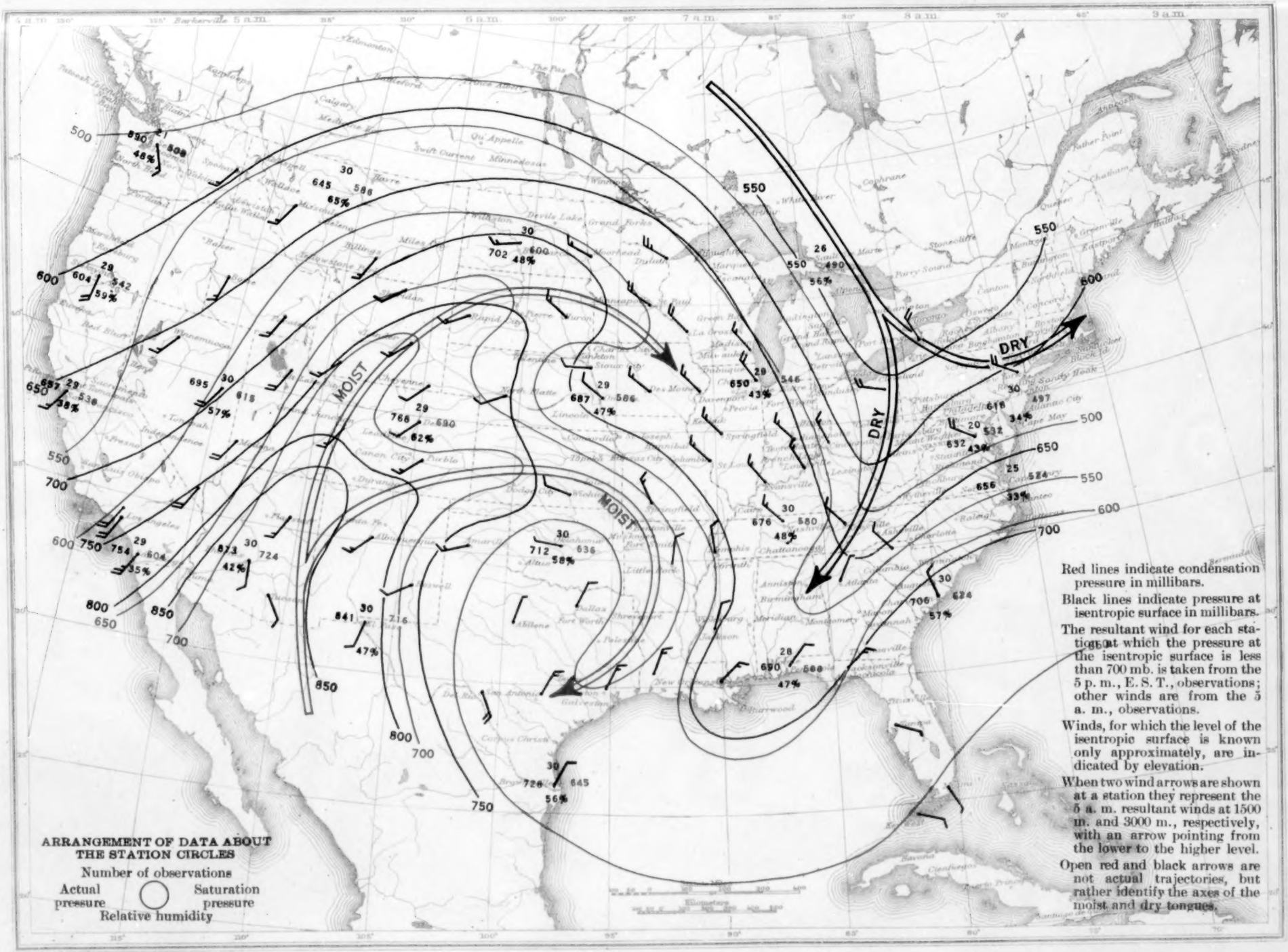
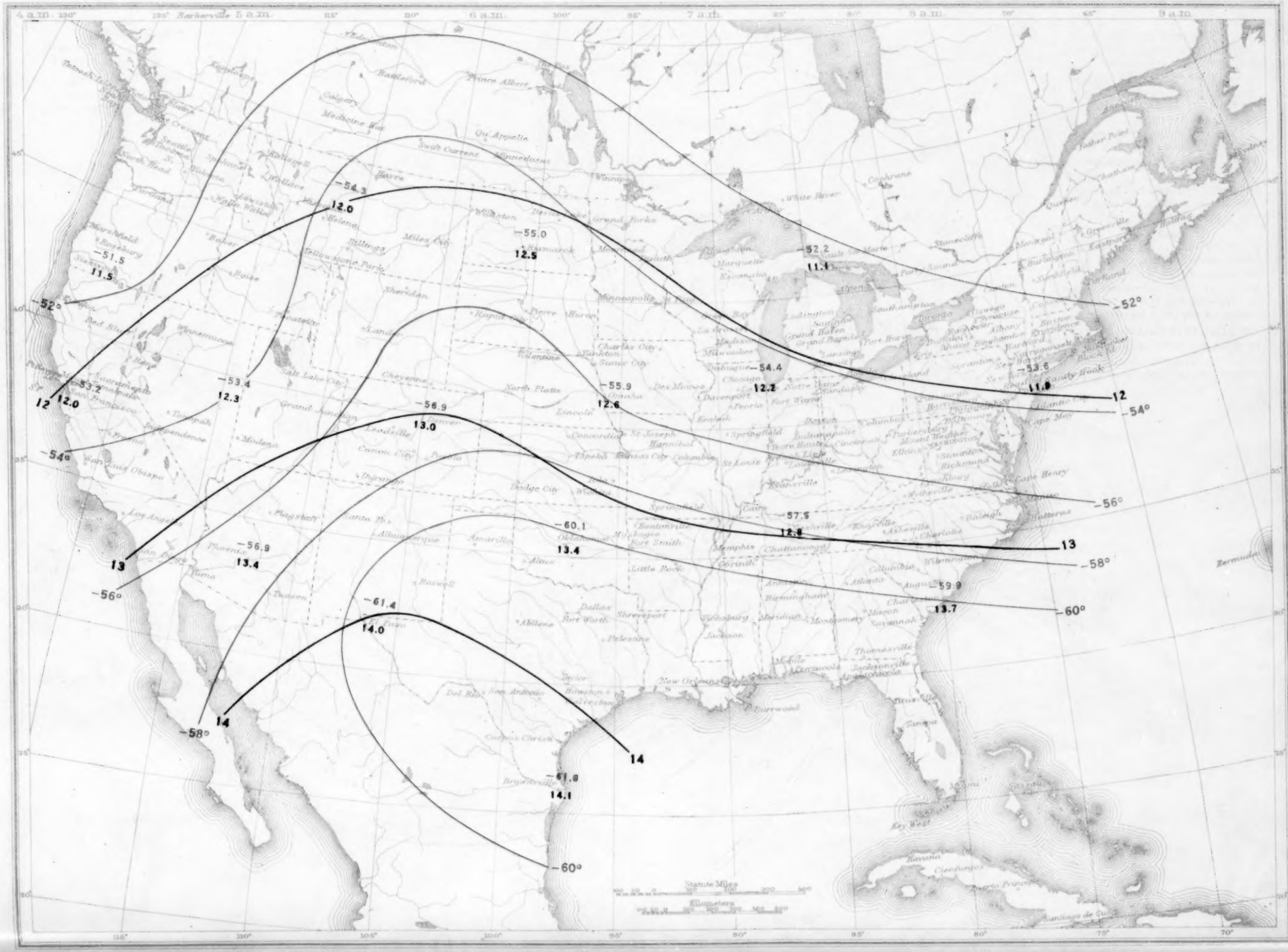

MOIST
DRY
MOIST
DRY
ARRANGEMENT OF DATA ABOUT THE STATION CIRCLES
Number of observations
Actual pressure
Saturation pressure
Relative humidity
Red lines indicate condensation pressure in millibars.
Black lines indicate pressure at isentropic surface in millibars.
The resultant wind for each station at which the pressure at the isentropic surface is less than 700 mb. is taken from the 5 p. m., E. S. T., observations; other winds are from the 5 a. m., observations.
Winds, for which the level of the isentropic surface is known only approximately, are indicated by elevation.
When two wind arrows are shown at a station they represent the 5 a. m. resultant winds at 1500 m. and 3000 m., respectively, with an arrow pointing from the lower to the higher level.
Open red and black arrows are not actual trajectories, but rather identify the axes of the moist and dry tongues.

Chart XIII. Mean Tropopause Data, Altitude (km.) (m. s. l.) Temperature (°C.) September 1940

(Data from table 4)